ACCIDENTS IN MINES.*

(*Continued from page 228.*)

VI.

Coal Dust.

The possibility of the blast of flame produced by a fire-damp explosion igniting the coal dust which more or less thickly covers the floor in and near the working places of a coal pit was first pointed out by Robert Bald in Jameson's Journal for 1828. But, even before then, the effects of dust in adding to the disastrous results of a fire-damp explosion had been noticed by J. Buddle, who was the chief of the Newcastle coal miners for nearly the first half of this century. In a published account of an explosion which occurred on the 3rd September, 1803, in the Wallsend Colliery, when thirteen men and boys were killed, and about twenty burned and injured by a consequent fire in the pit, he says, "The workings were very dry and dusty, and the survivors, who were the most distant from the point of explosion, were burnt by the shower of red-hot sparks of the ignited dust, which were driven along by the force of the explosion."

The important part which coal dust may play in aggravating and extending the injurious effects of fire-damp explosions was, however, first demonstrated by Faraday and Lyell in a report which they submitted to the Home Secretary in 1845, on the explosion at the Haswell Collieries in September, 1844, and on the means of preventing similar accidents.

After discussing the subject of the accumulation of fire-damp in the goaves of the mines, its dislodgment by the drawing of juds, by falls of the roofs in the goaves and by changes in atmospheric pressure, its diffusion into the surrounding air and into the mine ways, its ignition by a defective lamp, and the spreading of the flame to the gas mixture with which the goaf was charged, the reporters say:—"In considering the extent of the fire from the moment of the explosion it is not to be supposed that fire-damp was its only fuel; the coal dust swept by the rush of wind and flame from the floor, roof, and walls of the works would instantly take fire and burn if there were oxygen enough present in the air to support its combustion; and we found the dust adhering to the faces of the pillars, props, and walls in the direction of and on the side towards the explosion, increasing gradually to a certain distance as we neared the place of ignition. This deposit was in some parts half an inch, in others almost an inch thick; it adhered together in a friable coked state. When examined by the glass it presented the fumed round form of burnt coal dust, and when examined chemically and compared with the coal itself, reduced to powder, was found deprived of the greater portion of the bitumen, and in some instance entirely destitute of it. There is every reason to believe that much coal gas was made from this dust in the very air itself of the mine, by the flame of the fire-damp which raised and swept it along, and much of the carbon of this dust remained unburnt only from want of air. At first we were greatly embarassed by the circumstance of the large number of deaths from choke-damp, and in the evidence that *that* had been present in very considerable quantities compared with the small proportion of fire-damp, which, in the opinion of those in and about the works just before, must have occasioned the explosion. But, on consideration of the character of the goaves as reservoirs for gaseous fuel, *and the effect of dust in the mine*, we are satisfied that these circumstances fully account for the apparent discrepancy."

In January, 1845, Faraday delivered a discourse at the Royal Institution, in which he dealt with this report and the experimental inquiry made by himself with reference thereto. The substance of his conclusions regarding the part taken by coal dust in the Haswell disaster was then given in these words:—"The ignition and explosion of the (fire-damp) mixture would raise and then kindle the coal dust which is always pervading the passages, and these effects must in a moment have made the part of the mine which was the scene of the calamity glow like a furnace."

Although the report of Faraday and Lyell and subsequent writings on the subject by the former were published in 1845 these publications appear to have remained long unknown in France, for in 1855 M.du Souich, Chief Government Mining Engineer, of the Sainte Etienne Arrondissement, when referring to an explosion which had occurred at Firminy, advanced as new the view that the deposition of crusts of a light coke upon the props was due to dust which had been swept up and transported to a distance by the violent current produced by the explosion, and which, becoming in part inflamed, had extended and prolonged the destructive effects originated by the fire-damp. On the occasion of two explosions in 1861 M.du Souich again dwelt upon his views regarding the part played by coal dust in increasing the disastrous effects of fire-damp explosions. In 1864-67 M. Verpilleux instituted experiments which led him to the conclusion that coal dust plays an important part in coal mine explosions; the subject was also pursued by several other French mining engineers at about the same time, and especially by M. Vital, who made some experiments in 1875, in connection with the inquiry into an explosion which had occurred the year before in a part of the Campagnac Colliery where the existence of fire-damp had never been demonstrated. After examining the nature of the dust collected in the mine, and instituting some special experiments upon a very small scale, for the purpose of ascertaining whether, and to what extent, the flame from a small charge of powder was lengthened when projected, like the flame from a blown-out shot, into air containing coal dust in suspension, M. Vital concluded that very fine coal dust, rich in inflammable constituents, will take fire when raised by an explosion, and that portions are successively decomposed, yielding explosive mixtures with the air, whereby the fire is carried along, the intensity or violence of the burning being much influenced by the physical characters of the dust. He also suggested that an explosion of fire-damp, although taking place almost instantaneously, may inflame or decompose a small quantity of coal dust raised thereby, explosive action being thus propagated after the fire-damp explosion has ceased.

At about the time of M. Vital's investigation of the subject, Mr. W. Galloway commenced a series of valuable experiments upon a larger scale, with the view of investigating the influence of coal dust in colliery explosions, and the results were communicated by him to the Royal Society in 1876 and in several subsequent papers. The experiments described by him in his first paper led him to conclude that a mixture of air with the particular coal dust raised was not capable of carrying on, or transmitting, flame at the ordinary pressure and temperature, but that the presence of so small a proportion of fire-damp in the air that its existence could not be detected by the Davy lamp, caused the mixture of dust and air to burn freely with a red, smoky flame. In his second paper Mr. Galloway showed that the return air of a fiery mine which, though furnishing no indication of the presence of gas when examined in the usual way (by means of a Davy safety lamp), could in his opinion contain from 2 to 25 per cent., might be rendered inflammable by suspending coal dust in it. He also described experiments which appeared to demonstrate that flame, produced by the explosion of fire-damp in a particular part of a mine, might be propagated, at any rate to some extent, by coal dust raised by the explosion and thickly suspended in the air travelling through the mine, even in the complete absence of fire-damp in the air. The apparatus used consisted of a channel of considerable dimensions, through which a current of air, with or without coal dust in suspension, was passed; a chamber in which a mixture of pit gas (from Llwynypia Colliery) and of air could be prepared and exploded, was separated from the channel or gallery by a diaphragm composed of several leaves of newspaper which were burst through by the explosion of the gas mixture. The coal dust was placed on the floor of the gallery and upon shelves fixed in it.

The conclusions subsequently arrived at by Mr. Galloway, as the result of his more recent experiments with this apparatus and of his examination into the effects produced by the Penygraig explosion in December, 1880, and of the Risca and Seaham explosions of that year, does not support the earlier views taken by him, "that a mixture of air and coal dust is not inflammable at ordinary pressures and temperatures without the presence of a small proportion of fire-damp;" it being to the effect "that fire-damp is altogether unnecessary for the propagation of flame with explosive effects by a mixture of dry coal dust and air."

This conclusion coincides with that published in 1878, as the result of experiments commenced by Professor Freire Marreco, in conjunction with Mr. W. Cochrane, then of Elswick Colliery, in December, 1875. They used in their earliest experiments a very inflammable dust, obtained from the Brockwell Seam at Elswick Colliery, and employed a model colliery "bord," with headways. A fine gauze, kept down by weights, was applied at the top, upon which the dust was spread, and a strong current of air was established through the apparatus by means of a small model Guibal ventilator. Upon firing a small powder-charge from a pistol into the dust-and air-mixture with which the model was filled, so violent an explosion was produced that the woodwork was torn asunder, the Guibal ventilator was broken, and the weights were violently scattered. The experiments were for a time pursued by Marreco and Cochrane at Elswick Colliery, with an apparatus on a considerably larger scale, representing a bord and headway, and confirmations of the first result were obtained.

Mr. P. D. Morison, who became associated with these experiments, subsequently continued the work with Marreco at Harton Colliery in connection with the North of England Institute of Mining and Mechanical Engineers, which Society, as well as the Chesterfield and Derbyshire Institute of Engineers, has labored very usefully in this direction contemporaneously with Mr. Galloway. The apparatus used there (and with which experiments were continued by Messrs. Lindsay Wood, and G. May,) was a double gallery of wood, of smaller sectional area than Mr. Galloway's later apparatus, so arranged that the air current which passed into one gallery made its exit at the end of the second, alongside the point of its first entrance. The mode of proceeding was to fire successively two powder shots, in different positions in the gallery, from small cannon, so as to represent

*From "Final Report of Her Majesty's Commissioners appointed to inquire into Accidents in Mines, etc," 1886.

blown-out shots in the effects produced; coal dust was placed upon the floor of the gallery, and one shot was first fired against the air current, which was passing at a known velocity. The dust cloud thereby raised was carried along by the current, and a second shot was fired into it; in a large number of experiments made with many different descriptions of dust, the flame produced by the second shot was increased by that of inflamed dust.

The view taken by Vital, Marreco, and others, regarding the action of coal dust in propagating flame in air *free from fire-damp*, was to the effect that the first portions of dust acted upon by the inflamed gases of the shot yield inflammable gas, which mixes with the air and is fired, the non-volatile part of the coal being in part consumed and in part deposited as a friable coke. Marreco's examination of some coked deposits of dust collected by Mr. Galloway after an explosion, confirmed the observations originally made by Faraday and Lyell, that the coal dust is in part submitted to destructive distillation during the progress of the flame through the dust-laden air. Marreco considered that, although a proportion of the heat developed by the burning dust is absorbed by conversion into gas of portions of the coal-constituents, the heat of combustion of these suffices to leave a margin for the carrying on of the action from one particle of dust to another, provided these be in sufficiently close proximity to each other. In the experiments made by the Chesterfield and Derbyshire Institute of Engineers, in a very long gallery, results were obtained very similar to the above.

Instances are on record in this country and others, of the firing, with semi-explosive violence, of clouds of coal dust, produced either in the open air, or in localities where no fire-damp could exist, some portions of the mixture of dust and air having come into contact with a flame or fire. Thus Marreco and Morison mention a case of a considerable quantity of coal dust, which had been accidentally thrown over some screens at a pit's mouth, flashing into flame as the dust cloud came into contact with a neighboring fire, and burning a man very severely. In the case of another accident which occurred in a stone drift, where it was believed that no gas could possibly be present, a considerable body of rock was dislodged and coal dust was raised, by the firing of a shot, the flame of which ignited the air-and dust-mixture with very mischievous results. From 50,000 to 60,000 cubic feet of fresh air were said to be passing through the drift per minute when this accident occurred.

Considering that, since first Faraday and Lyell directed attention to the dangers of coal dust in mines, its behavior has been made the subject of many series of experiments and published reports here and abroad, it is remarkable that in most instances of coal-mine explosions, until quite recently, the probable effect of coal dust in increasing their magnitude does not appear to have received the serious attention which it merits at the hands of mine owners and of those in authority connected with coal mines. The evidence collected by us from Your Majesty's Inspectors of Mines and others with respect to the causes of accidents, included several statements regarding the possible influence of coal dust in aggravating explosions, b the preponderance of opinion of Your Majesty's Inspectors was against the view that explosions could originate with,or be to any great extent propagated by, coal dust *in the absence* of fire damp.

The only experiments on a practical scale bearing upon the subject, which appear to have been made until quite recently, are the very important ones carried out by Mr. H. Hall, Mine Inspector of the North Wales, etc., District, in conjunction with Mr. Clark, at about the date of Mr. Galloway's earliest experiments and communicated to the North of England Institute of Mining and Mechanical Engineers in June, 1876. Charges of from 1½ to 2½ pounds of powder were fired from a cannon, so as to produce the effects of blown out shot, at the end of an adit driven forty-five yards from the surface in a coal seam on the dip, the adit being arched with brickwork. It had a sectional area of about 30 feet and was ventilated by a vertical shaft. Sheets of very thin and easily inflammable material were supended at intervals of 15 feet by means of cross-pieces of timber, reaching from about two-thirds the height of the arching nearly down to the thill, and having small drill holes in them which faced the shot hole and were filled with gunpowder. In the first experiments the shots were stemmed with small débris of stone.

Having first found that neither the thin canvas nor the powder was burned in any case at a greater distance than 15 feet from the point where the shots were fired, Messrs. Hall and Clark proceeded to fire corresponding shots, stemmed with small coal, the floor of the adit being thickly covered with fine coal-dust to a distance of eight or nine yards from the seat of the shot. Evidence of the existence of flame to 30 feet, but not 45 feet, was obtained on firing a charge of 1½ pounds; to 45, but not to 60 feet with a 2 pound shot, and to 60 feet with a 2½ pound shot. Coal-dust was next scattered on deals along the whole length of the adit (the floor being very wet,) and, upon firing a 2½ pound shot the flame extended along the whole distance, and issued in large volume from the mouth of the adit. The force of the blast at the mouth was observed to be much greater when coal dust had been inflamed than when corresponding shots were fired in the absence of coal dust, and in the last experiment the blast was so fierce that, in the opinion of the experimenters, it would certainly have proved fatal to any one exposed to it. Messrs. Hall and Clark pointed out that besides the floor of the adit being wet and the roof dripping, the temperature of the air was only 50° F., and they therefore considered themselves justified in assuming "in dry mines, at a high temperature, and where the roads are thickly covered with fine dust, this dust will play a considerable part in extending and adding to the destructiveness of an explosion." In his evidence before us, with reference to these important experiments, Mr. Hall stated that the air in the adit was "practically" free from gas, but he did not maintain its absolute freedom.

Some decided opinions were expressed to us by several experienced witnesses that the supposed influence of coal dust in aggravating explosions was over-rated, and that it would certainly not lead to explosions in the absence of gas. On the other hand Mr. Galloway expressed a strong belief that some of the most extensive of recent explosions, such as those at Llan Colliery, Pentyrch, near Cardiff, and at Abercarne, were at any rate largely contributed to by coal dust, and more recently, on the occasion of the official inquiry into the Penygraig explosion of December, 1880, he gave evidence to the effect that the disastrous results of this explosion were mainly if not entirely ascribable to the action of coal dust, and he supported this opinion by the results of a minute examination into the condition of the pit, of the sufferers, etc., after the accident. The details of this examination were communicated by him to the Royal Society in June, 1881, (and revised in February, 1882,) when in concluding his paper Mr. Galloway states that from observations made by him in the mine, he estimated that the air-current receiving "a certain proportion of gas from each working place through which it passed in succession, would, on leaving the working place nearest the up-cast shaft, always contain rather more than 2 per cent. of fire-damp," and that "he had no doubt whatever that this *latent (sic)* fire-damp, acting in conjunction with the coal-dust was a most important factor in promoting and intensifying the explosion."

In a short paper communicated to the Royal Society in May, 1884, Mr. Galloway also refers to the explosion which took place in Dinas Colliery in January, 1879, the effects of which he had investigated, as another instance in which what he terms the "coal dust hypothesis" is in his opinion the only tenable explanation of the catastrophe.

When the terrible calamity which occurred at Seaham Colliery in September, 1880, was officially inquired into, the suggestion was very decidedly put forward by the miners' representatives that the coal dust which existed in large quantities in some parts of the mine, and especially near the spot where it was surmised that the explosion had originated, might have had much to do with the accident. Indeed the opinion was strongly entertained by some that it was entirely due to the ignition of coal dust, in the absence of gas, by flame from a blown out shot. The Home Secretary consequently requested one of the Commission (Sir F. Abel) to make experiments with samples of dust collected in different parts of the mine, and the results obtained with them led to an extension of experiments with dusts from other Collieries in different parts of the Kingdom, of which experiments the following is a summary as published in an Appendix to the original report:

The principal facts which appear to have been more or less conclusively demonstrated by the results obtained in the experiments with dust from Seaham Colliery and other sources, which form the subject of this report, may be summarised as follows:—

1. Several of this samples of dust collected in Seaham Colliery in November, 1880, exhibited signs of having been affected by heat; those indications were very slight in some instances, and considerable in only three samples, viz., in Q (scraped off stones on return side of Polka doors), R (from No. 1 engine plane at long turn), and T (from floor of No. 1 traveling road).

2 The two samples taken from the floor and off timbers at the curve in the stone drift (in proximity to where the shot was fired at the time of the explosion), as also the sample from near Maudlin engine, exhibited no signs of having been affected by heat.

3. The samples of Seaham dust exhibited considerable difference in regard to richness in coal, fineness and uniformity in this respect, density, &c.; the proportion of coal ranged from about 96 to below 54 per cent, in the dry sifted samples.

4. The chemical and microscopical examination did not furnish any data to lead to conclusions as to the extent to which the dust may have taken part in the production or augmentation, and transmission, of the explosion at Seaham Colliery.

5. But there was evidence of the existence of partially burnt dust at a number of points very distant from each other, and in different directions in the colliery.

6. The several samples of dust differed from each other considerably in sensitiveness, *i. e.*, in the readiness with which they promoted the ignition of a mixture of air and fire-damp in such proportions that it was not inflammable *per se* when brought into contact with the flame of a lamp, or, in regard to the proportion of fire-damp required by the several samples to impart explosive properties to them when suspended in air.

7. The most sensitive of the Seaham dusts were found to be those which were the richest in coal, and those which also contained the highest proportions of very fine dust.

8. Comparing the samples of Seaham dusts with dust obtained from other collieries where disastrous explosions have recently occurred, it was found that the most sensitive of the former was somewhat less sensitive than samples of dust obtained from Leycett Colliery (Fair Lady Pit), which ranked highest in this re-

spect among all the samples experimented with. The Leycett dusts corresponded closely in chemical character and specific gravity to the purest Seaham coal dust; their somewhat greater sensitiveness was perhaps ascribable to their remaining more uniformly suspended in air currents, but possibly also to some physical peculiarities.

9. One of the Seaham dusts which ranked high (third) in order of sensitiveness contained the lowest proportion of coal of all the samples, and consisted of non-combustible matter to the extent of nearly half its weight.

10. Special experiments which are instituted in consequence of the behavior of this sample, demonstrated that some perfectly non-combustible powders, which are also not susceptible of any chemical change when exposed to the action of flame, are very little inferior to the most inflammable or sensitive of the Seaham dust-samples in their power to bring about the ignition of an otherwise uninflammable mixture of fire-damp and air.

11. Mixtures of fire-damp and air, in proportions bordering on those which will ignite on the approach of flame, are inflamed instantaneously if they contain in suspension only few particles of such non-combustible dusts, or of the Seaham or other dusts from coal-pits.

12. This effect appears ascribable, at any rate in part, to the fact that these dust-particles, when they pass through a lamp-flame, immediately become incandescent and thereby localize and intensify the heat at those points, and thus bring about the ignition of the mixture of air and fire-damp by which they are surrounded. But some phenomena observed in the course of the experiments with non-combustible powders favor the belief that finely-divided solids of particular descriptions may exert another quite distinct kind of action when heated in fire-damp mixtures, which may at least contribute importantly in determining the ignition of gas-mixtures which are not susceptible of inflammation by the application of flame alone. This subject is about to receive complete investigation.

13. The smallest proportion of the fire-damp experimented with (from the nine foot Wigan mine) which became ignited and produced explosive effects, when passing a naked lamp flame at a velocity of 600 feet per minute, by having suspended in it the most sensitive of the Seaham dusts, was 2.5 per cent. The most sensitive coal-dust from Leycett, furnished a mixture which exploded when passing the flame, under corresponding conditions, with air containing only 2 per cent. of fire-damp. A mixture of 2.75 per cent. of fire-damp with air was ignited by the lamp through the agency of a perfectly non-combustible powder (calcined magnesia.)

In a current moving at a velocity of only 100 feet per minute, the Leycett coal-dust, suspened in air containing only 1.5 per cent. of fire-damp, became ignited by the lamp-flame, the ignition extending throughout the mixture.

14. The accidental presence of a proportion of fire-damp, which must have been considerably below the smallest above specified, caused one of the most inflammable of the coal-dusts (from Leycett) to become inflamed and to carry fire some distance, when a small powder charge was fired from a cannon while the dust was travelling.

15. The sensitiveness to ignition of a mixture of air with a small proportion of fire-damp is considerably increased if the source of heat is increased.

16. The results of the experiments with Seaham and other dusts appear to have demonstrations—

(a.) That coal dust in mines not only much promotes and extends explosions in mines by reason of the rapid inflammability of the finely-divided combustible, and of the readiness with which it becomes and remains suspended in air-currents; but

(b.) That it may also be itself readily brought into operation as a fiercely-burning agent which will carry flame rapidly as far as its mixture with air extends, and will operate even as an exploding agent, *through the medium of a proportion of fire-damp in the air of the mine, the existence of which, in the absence of the dust, would not be attended by any danger.*

(c.) That dust in coal mines, *quite apart from any inflammability which it may possess*, can operate in a distinct manner, as a finely-divided solid, in determining the ignition of mixtures of only small proportions of fire-damp and air, and consequently in developing explosive effects.

(d.) That a particular dust in a mine (such as the Seaham N dust) may therefore be a source of danger, even though it contains only a small proportion of coal or combustible matter. Although the explosion which may occur through the agency even of a non-combustible powder, in the manner described, may be of very mild or feeble character in the first instance, it may be almost at once increased in magnitude and violence by coal-dust which the first ignition will raise and bring into action.

17. The proportion of fire-damp required to bring dust in a mine into operation as a rapidly burning or an exploding agent, even upon a small scale, and with the application of a small source of heat or flame, is below the smallest amount which can be detected in the air of a mine, even by the most experienced observer, with the means at present in use, as has been already demonstrated by the experiments of Mr. Galloway. Indeed, with dusts of highly sensitive or dangerous character, under those conditions, and very possibly with dusts not more so than the least sensitive of the Seaham samples, *in the presence of a source of considerable heat and flame*, such as a blown out shot or an overcharged hole would constitute, a small proportion of fire-damp, the possible existence of which in the mine might not be in the least suspected, may serve as the inciting cause to the development of an explosion of coal-dust.

18. In the complete absence of fire-damp, coal-dust exhibits some tendency to become inflamed when passing a very large lamp flame at a high velocity; if exposed to the action of a large volume of flame, such as produced by the explosion of freely exposed gunpowder or gun-cotton, it exhibits, in addition, a decided tendency to carry or propagate flame. But, so far as can be determined by experiments on a moderate scale, this *tendency* (which was exhibited by Seaham X, K and S dusts, and still more by the more sensitive Leycett dust) is of limited nature, and very different indeed from the *property* of carrying or propagating flame, which even comparatively non-sensitive dusts possess, *in the presence of a very small quantity of fire-damp.*

In conclusion it may be admitted as possible that with the large volume of flame, and the great disturbing effect of a blow-out shot, as the initiatory cause of the ignition of dust, and its suspension in the surrounding air, such inflammation may, in the complete absence of fire-damp, be propagated to a greater distance than the results of small experiments would warrant one in assuming. But it can scarcely be maintained that the air of a mine in which the coal gives off gas at all, can be, at any time, *free* from fire-damp; and as the existence of very small and unsuspected quantities of that gas in the air of a mine may suffice to bring about the ready propagation of flame by coal-dust, and thus to develop violent explosive effect, it would appear needless to assume that coal dust may, in the entire absence of fire-damp, give rise to explosions, even of only limited character, in coal mines, in order to account for casualties which cannot be ascribed to the existence of accumulations or sudden outbursts of fire-damp.

The principal experiments were carried on at the Garswood Hall Colliery, where a constant and abundant supply of pit gas (a so-called blower) is brought to the surface, which had been kindly placed at our disposal by Messrs. Smethurst & Co. for the purposes of our safety-lamp experiments. The apparatus used at Garswood for the experiments with the Seaham and other dusts was similar in character to those employed by Galloway, Marreco, and others, except that special arrangements were made to secure accuracy and uniformity *in the velocity of the air-currents* passing through the gallery, *in the proportion of pit gas*, or fire-damp *used* with the air, and *in the intimacy and consequent uniformity of the mixture.** In order to raise the air-current in the gallery to a temperature similar to that of the atmosphere in colliery workings, the air-supply was drawn through a system of heated pipes, so that, when passing at as high a velocity as 1,000 feet per minute, its temperature could be raised up to 80° or 85° F. even in the very severe weather during which some of these experiments were made. It has been conclusively demonstrated during a series of coal-dust experiments made for us during the last five months of 1885, that this precaution was indispensable to the attainment of results which could compare with those likely to be produced by coal dust in most underground workings, where the prevailing temperature would be comparatively high.

The samples of coal dust experimented with were examined with respect to fineness, proportions of volatile matter and ash, and one or two other points, and they were all carefully dried before use.

Experiments were made in the first instance with a view of ascertaining the smallest proportion of fire-damp, which, when mixed with the air passing through the apparatus, would furnish an atmosphere capable of firing at a naked flame of a particular size, placed in the gallery. It was next ascertained what quantity of gas below that proportion was seeded to impart to the mixture of air with a large quantity of each particular coal dust the property of exploding throughout the gallery. By these experiments the samples were classed in the order of their sensitiveness to explosion, and it was found that, while those which were very rich in pure coal, and which contained the highest proportion of very fine dust, required the lowest proportion of fire-damp in air to bring them to explode readily when suspended in a dense cloud, the order of sensitiveness of samples containing higher proportions of non-combustible matter did not necessarily harmonize with their comparative richness in pure coal, nor with their comparative fineness. This was strikingly illustrated by two samples of dust from Seaham Colliery; one of these, taken from one of the roads, contained more than half its weight of non-combustible matter, yet ranked third in order of sensitiveness; another, which contained considerable more coal and a somewhat larger proportion of the finer dust, ranked only fifth.

Another point clearly established, and confirming by more accurate data the observations of earlier experimenters, was, that the proportion of fire-damp required in a mine to bring dust readily into operation as an explosive material, when thickly suspended in the air, borders upon, and is even sometimes below, the smallest amount (about 2 per cent.) which can be detected in the atmosphere of a mine, by the most practised observer, with the use of the Davy lamp. Explosions were produced by dust suspended in air travelling at a velocity of 600 feet per minute, when fire-damp was present in proportions ranging from 2 to 2.75 per cent.; in currents of low velocity the same result was produced with a sensitive dust in the presence of only 1.5 per cent. of fire-damp; ignitions, which approached explosions in their nature and extended to considerable distances, were moreover obtained with this dust in air containing still smaller proportions of gas. Mixtures of fire-damp and air bordering upon those which would ignite upon the approach of flame were found to be instantaneously fired by a lamp if they contained only a few particles of dust in suspension, and, in connection with this fact, the interesting observation was made that such dust particles need not be inflammable nor combustible to produce the result named. Mixtures of air and gas which passed a naked flame without any symptom of ignition, were inflamed when particles of a fine, very light powder, such as calcined magnesia, were suspended in them. The action of certain of the pit-dusts which contained comparatively little coal, in determining the ignition of mixtures of air and small proportions of fire-damp, was possibly of the same character as that of calcined magnesia. The power of favoring the ignition of mixtures of fire-damp and air was not exhibited by some other powders similar in fineness to the latter, but differing in structure and density from this and one or two other non-combustible dusts which may be called active; even different samples of magnesia, differing somewhat in lightness from each other, appeared to possess the activity in different degrees. These facts seem to favor the view that a dust which possesses peculiar physical characteristics exerts a contact or

*The results of analyses of samples of the gas and air mixtures, collected from different places in the gallery afforded most satisfactory proof of the attainment of these results.

catalytic action upon gas-mixtures, similar to that known to be possessed by platinum and some other substances under particular conditions. Thus, when finely-divided platinum, or even a clean recently heated surface of the compact metal, is brought into contact with mixtures of hydrogen, or of hydrocarbon gas or vapor, with oxygen or air, oxidation of the hydrogen or the hydrocarbon is at once established, and proceeds at a rapidly accelerating rate, as the chemical activity is promoted by the accumulating heat, so that the metal is speedily raised to a temperature sufficiently high to bring the surrounding gas-mixture to the exploding point.

In many of the experiments with calcined magnesia just referred to, it was distinctly noticed that a dark space intervened between the gas-flame used as the source of heat and the flare produced by the ignition of the gas-mixture through the influence of the dust cloud suspended in it; this would seem to indicate that the dust particles, immediately upon passing through the flame, establish some amount of oxidation of the fire-damp, which proceeds with increased rapidity as the dust becomes more highly heated through the chemical action developed, so that, within a short distance from the point where the heating commences, the dust becomes incandescent, and the ignition of the gas-mixture follows. There appears little doubt that this action of non-combustible dust in promoting the ignition of gas-mixtures which, in the absence of dust, are not susceptible of ignition by the volume of flame or highly heated matter projected by a blown-out shot, constitutes one element in the dangers arising from the presence of dust in the air of a mine which contains a small proportion of fire-damp, and in which a large body of flame is accidentally produced, either by a powerful blown-out shot, or by a fire-damp explosion of local character. In the memoir published by Mallard and Le Chatelier, in 1882, on the part played by coal-dust in mine explosions, those observers describe experiments carried out with non-combustible dusts and mixtures of air with very small proportions of gas; the method of experiment was different from that pursued by Sir F. Abel, but the results obtained were quite confirmatory of those arrived at by him.

Numerous experiments similar to those of Marreco and Morison were made by Sir F. Abel at Wigan, with mixtures of air and coal dust from Seaham, and other collieries, in the complete absence of fire-damp, which were passed through the apparatus at different velocities up to about 1,000 feet per minute. Small cannon, specially constructed to ensure uniformity in the volume of flame produced by them at different times, were fired, either singly or in pairs, in rapid succession; freely exposed heaps of gun-cotton and of slow and quick-burning gun-powder were also exploded in the dust-laden air. The results occasionally confirmed to some extent those of Marreco and Morison and of the Chesterfield experimenters. At velocities of 400 feet per minute the dust, which was either passing at the time or was raised by the concussion of a first shot, did not appear to produce any increase in the volume of flame furnished by the cannon, but a decided though inconsiderable lengthening of the flame was several times observed at higher velocities and with the employment of the most inflammable dusts. Some of these, when thickly suspended in air travelling at velocities of 500 to 1,000 feet per minute, and exposed to the action of a large flash of flame (as produced by the loose heaps of gun-cotton and blasting powder), exhibited a tendency not only to burn explosively in or close around the flame, but also to propagate flame or cause it to travel along some distance; but the most decisive of the results were not of a nature to warrant the conclusion that flame could be carried along to very great distances by coal dust in the *complete* absence of fire-damp.

There can be no question that the magnitude of first ignition in the dust-laden atmosphere must greatly influence the extent to which the propagation of flame in this way will extend, and Mr. Galloway's experiments at Llwynypia, therefore, were more likely to develop conditions approaching those of the real state of things in a mine than experiments in galleries of smaller dimensions and with small initiative volumes of flame. The earlier experiments made upon a much larger scale by Messrs. Hall and Clark in an adit had, however, a decidedly more direct bearing upon results likely to be actually produced underground in a dust-laden atmosphere. In the course of those experiments flame was carried by dust, first ignited by the flame from a blown-out powder-shot (2½ pounds), to a distance of 135 feet, and extended into the open air beyond the mouth of the adit. It is of course, possible that the coal dust used may not even have been of the most inflammable description, and that its fineness and density were not most favorable to its becoming very thickly suspended in air; but, on the other hand, it must be remembered that Mr. Hall stated in his evidence to us that the atmosphere in the adit was only "practically" free from gas.

The volume of flame from a blown-out shot in a mine-working is generally considerable, but it appears that exaggerated estimates are entertained of the distance to which, *in the absence of dust*, flame will be projected, and there can be no doubt that the volumes of flame, which have been occasionally observed to extend to many yards from the spot where a shot was fired, were in a great measure due to the ignition of dust raised by the concussion and the rush of air at the instant of firing, and possibly also to the circumstance that small coal was used for stemming the charge. Mr. Hall found that the flame from a blown-out shot of 2½ pounds of powder reached to an extreme distance of only 15 feet when no dust was present. In 1881 that official directed the attention of Sir F. Abel to the occurrence of two accidents in the Liverpool district, each one occasioned by a shot of only 1 pound of powder blowing out its stemming without shaking or bringing down any coal. In both instances the shotlighter and two pitmen had retired about 100 feet from the seat of the shot, that is, about 30 feet in a straight line with it, and 60 to 80 feet along both directions of a working running at right angles to the drift in the face of which the charge was fired. In one case a man was killed, and serious injuries were sustained by the other men in both instances. There were signs of charring upon the props up to, and 5 or 6 feet beyond, where the men were standing, but they did not extend farther. The drift and the level in which these accidents occurred were 5 feet high and 12 feet wide. Mr. Hall stated that a strong impression existed among mining men on the spot that the flame of the shot, quite unaided by gas or coal dust (the latter was known to be present), would have extended so as to produce the effects described. This appeared so at variance with the results of Messrs. Hall and Clark's experiments that an attempt was made by Sir F. Abel shortly afterwards to obtain some further experimental data upon a large scale with regard to the distance to which any burning effect from a blown-out charge of 1 pound or 1½ pounds of powder would extend in a mine-working, in the absence of coal dust.

The locality selected for the first experiments formed a portion of some obsolete fortifications at Chatham, and consisted of a masonry gallery or *Capornier*, 8 feet 8 inches high to the spring of the arch and 8 feet wide below the arch, to a distance of 28 feet from the closed end: from that point it tapered on one side to 6 feet along a length of 2 feet 6 inches, and was 6 feet wide for a length of 3 feet 6 inches, up to a pier or square column 4 feet by 3 feet six inches, round which the gallery curved, being at this part 4 feet 2 inches wide. The straight part of the gallery, from the dead wall at one end to the projecting pier at the other, was 34 feet long. In the wall to the left of the blocked end, there were six narrow loopholes up to the curve, commencing at 18 feet from the end, and 2 feet 6 inches apart; in the opposite wall there were four, commencing at the same distance and 5 feet apart. Over the wall at the blocked end of the gallery there was an opening into the outer air, and a considerable current of air passed through it along the gallery to the curved end, which led into a long narrow gallery at right angles to this wide one, and having large chambers opening into it.

In some preliminary experiments an iron tube was let into the face of the wall at the blocked end of the gallery, so as to represent a strong blast hole, and this was charged with 1½ pounds powder, untamped in some cases and tamped in others. Threads of gun-cotton were suspended from the roof of the gallery at a distance of 28 feet and farther along, and observers were stationed outside the gallery opposite the several loopholes. But, although none of the gun-cotton was inflamed, there were conflicting opinions concerning the distances at which flame was seen, probably caused by the general illumination of the gallery by the flash of the explosion. The iron tubes containing the charges were more or less considerably torn, so that some of the force of the exploding charge was expended laterally, and the full effect of a blown-out shot was therefore not obtained. The following method of experimenting was eventually adopted:—Charges of 1½ pounds and 2 pounds of powder, untamped or tamped, were fired from a small roughly bored out gun block, the bore of which was 1 foot 9 inches long and 2¾ inches in diameter; the gun was raised so as to project the frame right along the gallery at about its center. A light woodwork frame 5 feet square was fitted with 36 cross wires 1 foot apart, so as to furnish 36 points of intersection: to each of these points a small tuft of gun-cotton was attached, and the target thus fitted was fixed vertically so as to face the charge. In this way pieces of gun-cotton were distributed uniformly over all parts of the target, which filled a great part of the section of the gallery, the distance of the target from the charge being gradually increased in successive experiments.

(TO BE CONTINUED.)

STEEL PIPE MAKING IN GERMANY.—It is reported by the Berlin *Eisenzeitung* that the new process for making steel pipe at Burbach is very successful. A syndicate has been formed to build works at Burbach, the capital being 1,200,000 marks, of which 500,000 marks, are issued to the patentee, A. Mannesmanne, of Remscheidt. It is stated that Funke and Ebers, of Hagar, Germany, have also purchased patent rights, and a large firm in Paris propose to apply the method to the manufacture of copper tubing The process is as follows: As soon as the steel is cast into the round mold a core is thrust into the steel so that a tube is formed between it and the walls of the mold.

In order to prevent cracking of this annular casting during cooling, the core is so made that it follows up the shrinkage of the steel. The steel cup thus obtained may then be rolle n ordinary train.

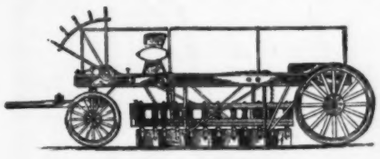
Municipal Engineering; Paper No. 3.*

WASHINGTON, D. C.

(*Continued from Page 228.*)

Garbage Removal.

Garbage is removed by contract, it is collected from hotels daily, and from private families three times a week in summer, and in winter twice. The contractor is required to collect it in barrels or other receptacles having a tight fitting cover, but much is collected by private "slop-men" with any kind of a cart and barrel they see fit to use. For collecting house garbage the contractor uses a low-hung wagon, carrying ten or twelve barrels for streets, and carts for alleys; the barrels simply have wooden covers laid over the top. There is no special form of hand receptacle, but more often than otherwise a common wooden bucket kept in the back yard



(Street Scraper, pat'd May 20, 1873.)

Plate 26.—Mud-scraping Machine, (*See page 230.*)

is used. Ashes are not removed by the garbage contractor, but are collected by men with carts who haul them to the nearest dumping ground, the expense being paid by the occupant of the house. Dead animals are removed by the garbage contractor in a wagon having a tight body, the rear end of which lets down to form a platform upon which the carcass is drawn from the street by means of a windlass at the front end of the wagon, near the driver's seat.

There are a few old-fashioned privies in use in the city, which are cleaned by the garbage contractor by means of an odorless excavating apparatus constructed under the patents of William Painter and Louis R. Keizer, and manufactured by the Odorless Excavating Co., of Baltimore, Md. This apparatus consists of a peculiarly constructed pump, mounted on a light hand-truck, which forces the contents of the privy vaults through a hose into a tight barrel having but one outlet for the escape of air or gas, through a charcoal furnace in which a bright fire is kept burning, thus distroying all noxious gases.

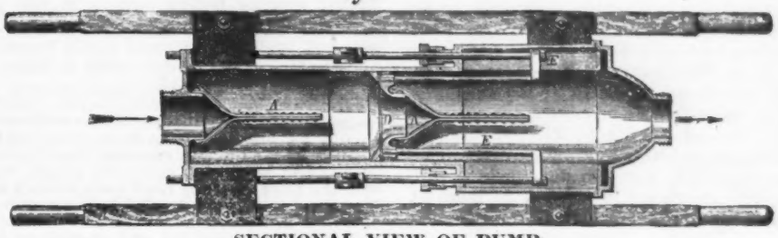
The following cuts of the pump (Plate 27) and the description, taken from a pamphlet published by the Odorless Excavating Co., of Baltimore, Md., will render the construction and actions of the pump plain.

"The chief point of novelty in the pump employed, lies in the valve. Virtually, these appliances, by their construction and position in the pump, form a continuation of the connecting hose leading from the vault to the tank, and being in direct line with each other, offer little resistance to the passage of the material. The valve, as shown in the sectional view of the pump, Fig. 2, and in the smaller engravings, Figs. 3 and 4, is made of soft, elastic vulcanized rubber, *A*, tubular in form, and being composed of two flat pieces placed face to face and riveted together at their edges, is, in its normal condition, collapsed. Its length is equal to some three diameters when open. One end is distended, and, embracing a collar, *B*, that surrounds the port, is securely fastened thereto by clamps and bolts. Straps or braces, *C*, are arranged at the base of the valve to directly guard the port and prevent it from being forced into the port by external pressure. The valve is therefore, essentially, a collapsible tube, one end of which is permanently distended to embrace the port through which the material passes. The passage of material in one direction through the valve, is direct and unresisted, while it cannot take place in the opposite direction, by reason of the collapse of the valve by the pressure on its sides. The valve, being of much greater length than diameter, presents an extended bearing or contact surface between its two sides, which closely engage and surround whatever obstruction may be passing through it at the time of its collapse, forming about the obstruction an air-tight joint, as shown in Fig. 4. At the succeeding stroke of the pump the valve is again distended, and the obstruction passes forward without in the least interfering with the action of the pump.

The pump is single-acting, (Fig. 2,) and in form a straight cylinder, provided with one fixed valve, (the induction,) and one movable—both marked *A* in the engraving—the latter attached to the piston *D*, moving in the center of the cylinder.

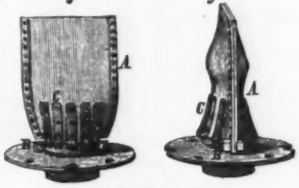
The passage of material through the pump is therefore direct and without counter currents; and such is its remarkable capacity for passing obstructions, that sticks, stones, shavings, rags, ropes, bottles, bones or other obstructions—and indeed an entire pair of heavy cloth pants or a full sized army blanket—are pumped through with ease. In fact, any obstacle not too large to enter the suction hose, and of whatever length, will pass freely through the valves without interfering with their action. As an instance, a large rope some 40 feet in length has been pumped through with the greatest facility."

Fig. 2



SECTIONAL VIEW OF PUMP.

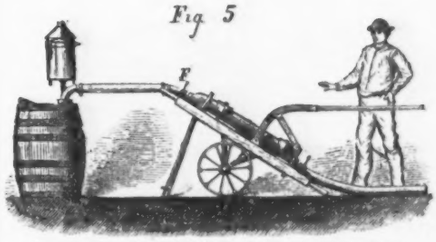
Fig. 3 *Fig. 4.*



PUMP VALVES.

Fig. 4 shows the Valve with an obstruction passing through it.

Fig. 5



Apparatus as Employed in Washington.

Plate 27.—Odorless Excavator.

Storm-Water from Roofs.

Rain-water leaders when inside of houses must be of iron, with lead or screwed joints; when outside they may be of tin to within 5 feet of the ground, and from this point they must be of iron pipe, not less than 4 inches in diameter. Where they open under a window they must be trapped. The main drain of each house must have a running trap outside any house connection. The rain-water leader enters this drain inside the trap.

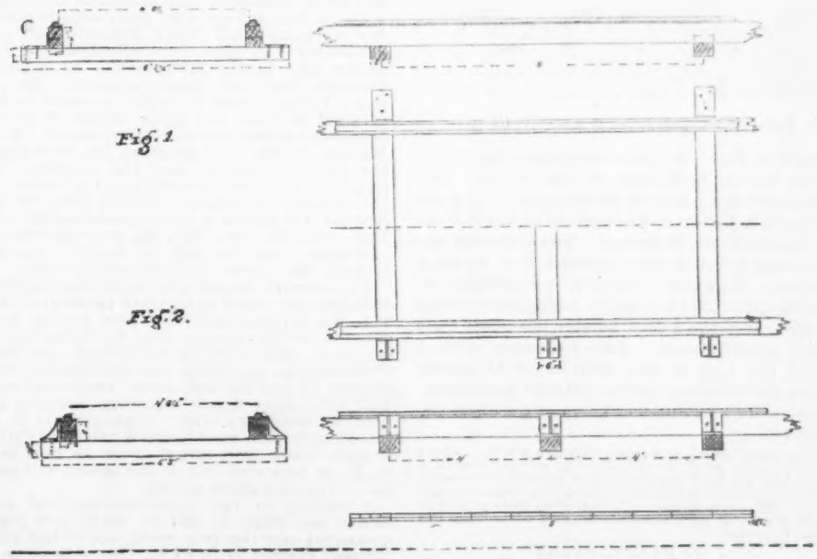


Fig. 1

Fig. 2.

Plate 28.—Washington City Railways.

Street Obstructions.

Street obstructions are defined by the laws of the City of Washington as follows: "It shall not be lawful for any person or persons to place or cause to be placed, or allow to remain, any goods, wares, or merchandise, or any sign, box, barrel, or other obstructions on

The amount of garbage removed for the year ending June 30, 1885, was:

Dead animals	8,876
Tons of garbage	13,930
Barrels of night soil	23,827

The garbage is hauled by the contractor to points outside the city and made into compost heaps.

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either the footways or roadway of any street or avenue further than 4 feet from the building line." For allowable obstructions, see Building Regulation of the District of Columbia, Section 23, 24, 25, and 26.

Street Railways.

There are in the City of Washington five street railway companies, operating an aggregate of sixty-four miles of single track.

The road-bed and details of rail and fastening of the Washington and Georgetown Railroads are shown in Plates 30 and 28, Fig. 2, and the same for the belt lines are shown in Plates 29 and 28, Fig. 1. The rails of the Washington and Georgetown Railroad weigh forty two pounds per yard, and together with the joint are shown in section in Plate 30. The joint plate is 18 inches long, and together

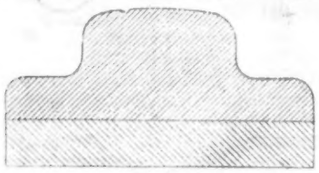

Plate 29.—Belt Line Rail.

with the rail is secured to the stringers by four spikes at each joint. The stringers are spiked to the cross-ties and have angle-irons, shown in Plate 28. Fig. 2, which shows a cross-section, a half plan, and a side elevation of the track. The stringers are 5 inches by 6 inches, and the ties 4 inches by 6 inches, spaced 4 feet apart between centers. The rail of the Belt Line weighs thirty-five pounds per yard, and together with the joint-plate is shown in Plate 29. The joint plate is 12 inches long, and there are four spikes passing through the rail and plate at each joint.

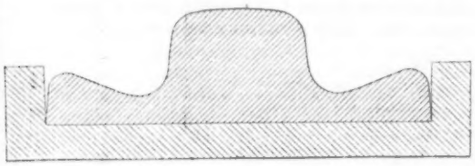

Plate 30.—Washington & Georgetown Rail.

Plate 28, Fig. 1 is a cross-section, a side elevation, and a half plan of the track. The stringers are 4 inches by 6 inches. They are spiked to the cross-ties and have angle-irons as shown in the drawings. The cross-ties are 4 inches by 6 inches spaced 8 feet between centers. The space between the rails and between the tracks is usually paved with cobble stones, and the 2 feet outside the outer rails with granite block. The following extract from the laws of the District of Columbia gives the liabilities of the railroad companies, in regard to paving and keeping streets in repair:

> When any street or avenue through which a street railway runs shall be paved, such railway company shall bear all the expense for that portion of the work lying between the extreme rails of the tracks of said roads, and for a distance of 2 feet from and exterior to such tracks on each side thereof, and of keeping the same in repair.

(TO BE CONTINUED.)

PITTSBURG'S SOUTH SIDE WATER SUPPLY.—Messrs. Booth & Flinn have finished the work of laying the 24-inch main across the Monongahela river. The contract was awarded two years ago and the contractors hoped to complete the work in one summer, but as the expectations of low water were not realized, they had to build coffer-dams, which were several times washed out by floods. The contract price was $11.85 per foot, but the cost to the contractors has been over $20 per foot. Now that the pipe is laid it is not needed, the contract between the city and the Monongahela Water Co. doing away with the necessity of the city furnishing water to the South Side.

The New Market Street Bridge in Philadelphia.

This bridge, which is now under contract, crosses the river Schuylkill in Philadelphia at Market street. It will replace a Howe-truss bridge built by the city in 1876 to replace a still earlier wooden bridge burned in the year named. About a year ago this hastily constructed bridge was deemed unsafe for travel, and the temporary bridge shown in Plate III was erected and the traffic turned upon it.

To go back some years, in September, 1882 City Councils directed that plans and specifications should be prepared for a stone bridge at this same point, and it was specified that it should be 100 feet wide and have five spans, three over the river and one land span at each end. Plans were prepared by Chief Engineer S. L. Smedley in accordance with this resolution and bids were called for and opened on Jan.

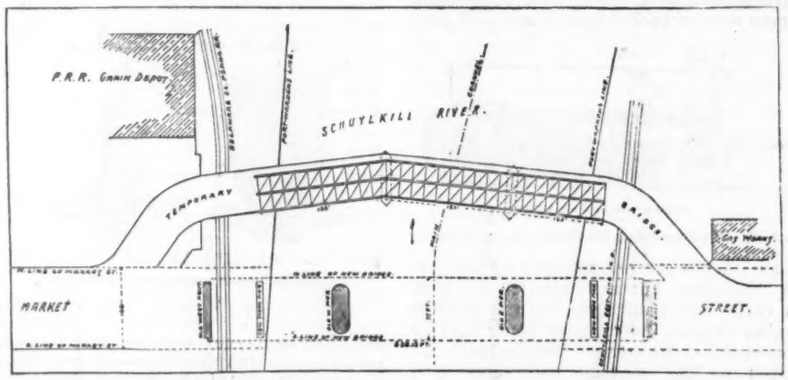

Plate III. General Plan of Site of Market Street Bridge.

7, 1884, as follows:

Lindenthal & Friday,	$1,220.000
Smith & McGaw,	1,197 000
H. C. Clark & Co.	1,160,000
R. A. Malone & Son,	1,100,000

But as only $300,000 had been appropriated by councils for this work and the limitation act made trouble in providing the very handsome additional amount required, the matter lay dormant until Chief Engineer Smedley submitted the plan here illustrated. This action was partly in response to a public demand that the money required for one stone bridge would be better invested in two of steel or iron, the extra bridge to be put across the same river at Walnut street. R. A. Malone & Son of Lancaster, Pa., were again the lowests bidders, and the contract was awarded to them in June last, but vetoed by the Mayor for reasons already given in this journal and passed a month ago over his veto. The price bid was $271,000, and the time of execution was limited to twelve months. Messrs. Malone are now actively at work.

The general situation of the bridge together with the temporary bridge will be seen in Plate III. When completed this new bridge must provide for the passage over the Schuylkill of a 16-inch, and a 12-inch water main, the West Philadelphia gas-main and the double-track system of the Market street cable railway. The provisions made for these features are seen in the plans. The Pennsylvania R. R. Co. occupies the west bank of the river with a branch track, and the B. & O. or East Side R. R. is now building a line which will pass under the east shore arches.

According to the specifications, the new bridge (see Plate I) will be 538.15 feet long, measured over the iron-work, and 77 feet wide between centers of hand railing; this width is so divided as to give 52 feet of roadway and a footway 12 feet, 6 inches wide on each side. The clear headway under the center of the suspended span is about 23 feet above high water in the Schuylkill river.

The plan includes the adaptation of the old pier and abutment foundations to the needs of the new superstructure; provided, that upon examination by the recently appointed consulting engineers, Messrs. J. M. Wilson and John H. Linville, these foundations be found sufficiently good for the purpose intended.

The present river piers are to be removed to the offset shown near mean low water mark, and rebuilt to the bridge seat with regular coursed ashlar granite masonry to the new bridge-seat; these piers will then be 27 feet wide at the base and 20 feet at the top and be 68 feet long with circular ends. Each of the shore or anchor piers will be entirely new, and will rest upon 100 white-oak piles, cut off 8 feet below city datum and capped with a grillage and platform 10 feet wide by 74 feet long. They will be built of coursed granite masonry and contain ten vertical openings for the clear passage of anchor rods, with horizontal openings near the bottom to give access to the anchors. These piers will be 6 feet wide and 70 feet long under the coping.

The masonry of the present east abutment is to be removed to the old skew-back and rebuilt with regular coursed masonry to a width of about 69 feet, and 8 feet wide to the seat of the plate girders. The west abutment will be treated practically in the same manner. The present retaining wall will be simply raised about 3 or 4 feet and capped with a heavy granite coping, though some new wall will have to be built.

The east and west shore spans will be made up of eight wrought-iron plate-girders 62 feet, in length and 5 feet 2½ inches in depth, resting upon the shore piers and abutments. As this bridge is to be arranged for the passage of the Market St. cable railway, with its two lines of cables, two of these girders will be located under each cable-slot and 2½ feet apart (see Plate II); the other girders will be placed generally 13½ and 27 feet therefrom. The girders will be all of the same general dimensions, each having web plates 5 feet deep and ⅜-inch thick, four angle bars 6x6x⅝ inches, two top flange plates, 16x¼ inches and 16x⅝-inches; and two bottom flange plates, each 16x⅝-inches; all extending the whole length of the girder with stiffeners, lateral and transverse bracings. Over the railroad tracks, which are found on each bank of the river, galvanized iron (No. 24 B. W. G.) will be placed on a wrought-iron frame work 28 feet wide to protect the iron work.

The cantilevers and suspended trusses will be in five lines, one being on the center line of the structure, and the others having 15 and 13 feet distances between centers. Each cantilever has fourteen panels of 10.7 feet, and additional panels of 6.67 feet at the fixed end, and 10.45 at the free ends. Each suspended truss has eight panels of 9.5 feet each. To provide a clear space for the passage of the cable grip, the upper lateral bracings are placed below the top chord (See Plate II.); and attached to the verticals of trusses are wrought-iron transverse plate girders, 18½ inches deep, carrying four lines of longitudinal lattice girders, 19¾ inches deep, extending between the two shore piers which support the ends of the floor beams.

In the roadway and footway formation, the transverse floor-beams are placed 3 feet apart longitudinally; these beams are 9 inches deep, weigh 81 pounds per yard, and must be in three pieces only. The footway is supported by six longitudinal lines of channel beams as shown in Plate II. The beams of both road and footway carry Mallet wrought-iron buckle-plates, ⅜ inches thick and 3 feet square.

On these buckle-plates, under the roadway, is first placed a layer of bituminous concrete shaped to the crown of the roadway; and on this an asphaltum pavement 2½ inches thick. Adjoining the curb on each side, will be 18 inches in width of bituminous asphalt mortar forming a gutter. The shore spans are paved with granite blocks as shown in the plate.

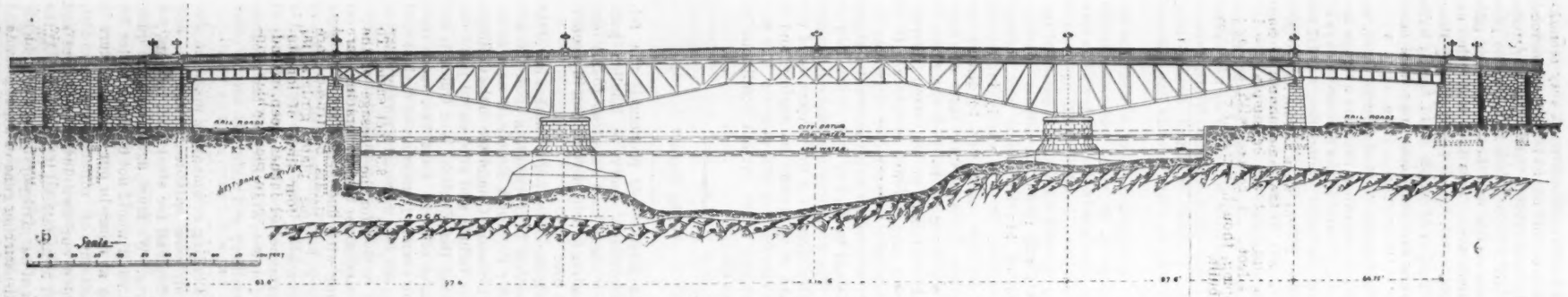

Plate I. General Elevation, Market Street Bridge, Philadelphia, Pa.

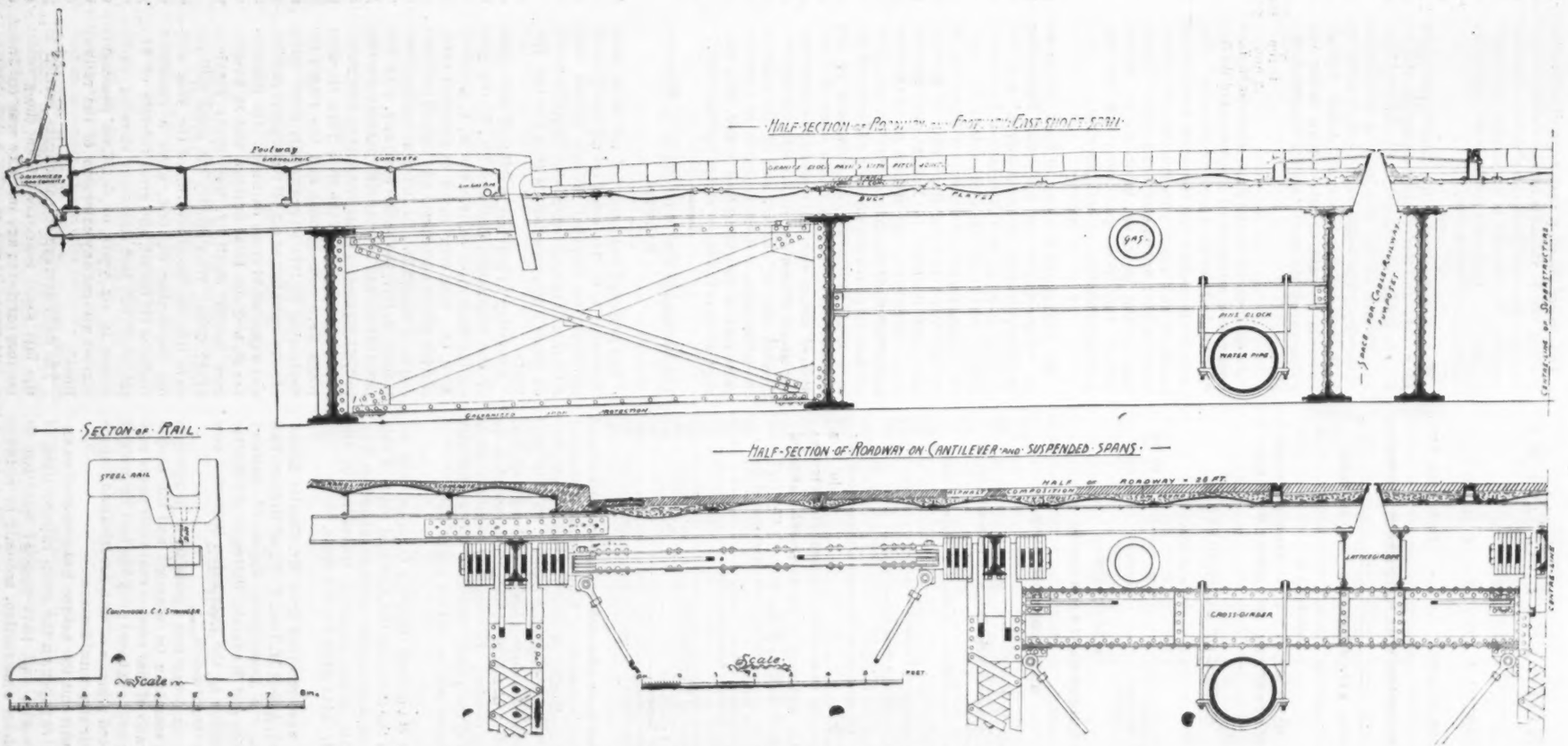

Plate II. Half-sections of Roadway, Market St

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Subscribers who wish to have complete files of this year's numbers of ENGINEERING NEWS *must make application at once for missing numbers or to replace mutilated copies. We will give one month's subscription for each copy of Nos.* 13 *and* 14 *of this year, uninjured, mailed to us during October. In wrapping cover the whole length of the paper, otherwise they arrive with torn leaves and we will not accept them.*

THE Manhattan Railway Company has reduced the fares on the Elevated roads of this city—all lines—to five cents, to take effect Nov. 1. This is the cheapest travelling in the world: nine miles for five cents.

WE have received from Mr. Charlie Kilner Sheard, Assoc. M. Inst. C. E., of Hobart, Tasmania, "A Descriptive Paper of Railway Practice and Mountain Railways of a similar description to the Tasmanian Railways now under Construction."

The purpose of this document is to prove to the Tasmanian Government and the people generally of that section that their roads now being built are based upon the best known and accepted practice of both America and Europe in their structural features.

To this end the author has prepared an exhaustive paper on the steep railway lines of the world, and pays especial attention to American construction, not only in railways but in bridges, high trestles, elevated railways, etc.

The paper shows a vast amount of varied reading and is valuable for the statistics here brought together from many widely scattered sources. Mr. Sheard is seemingly very much in favor of American methods as applied to Tasmanian construction.

THE tenth meeting of the Connecticut Civil Engineers' and Surveyors Association, will be held at Bridgeport, Conn., at the office of Hull and Palmer, on the 27th inst. A description of the city's new water-works will be given by B. H. Hull, chief engineer, and a visit will afterwards be paid to the works, under the guidance of Mr. Hull and his assistant, Mr. Palmer.

AN engineer of this city was attracted by the loud-voiced attempts of a street fakir to sell "An Atlas of the World, all for 25 cents." The engineer remarked that the maps were rather small for any useful purpose, but was somewhat startled by the statement that—"Every map in the book, sir, is drawn to *natural scale.*" Our friend concluded that he was lacking in shelf-room and passed on.

MR. ALEXANDER BORODIN, of Kieff, in a paper on "Experiments on the Steam Jacketting and Compounding of Locomotives," read before the Institution of Mechanical Engineers, at its recent London session, details the careful trials, conducted under his direction on the approved and excellent plan of Messrs. Hirn and Hallauer in France, and reaches many interesting conclusions as to the best method of using steam in locomotive cylinders. All tend to prove the superior efficiency of the compound locomotive as compared to the simple ordinary engine, on the score of a decreased steam and fuel consumption, averaging about fifteen per cent. without any increased cost of engine, and on the score of the advantages of decreased cost of boiler repairs, and of providing feed water, etc., consequent upon the lesser steam consumption.

The Increase of Travel on the N. Y. Elevated Railways.

The proposed reduction of all fares, after November 1, to five cents on all the lines of the New York elevated railway system calls attention to the phenomenal increase in travel on these lines, especially within the last few years.

According to the last published statement of the Manhattan Railway Co., in the year ending September 30, 1873, the N. Y. Elevated R. R. Co., with four miles of operated road, carried 642,025 passengers and earned gross receipts of $64,602.55. In the year ending September 30, 1877, the same company, with five miles of line, had increased its passenger traffic to 3,011,862 and its gross receipts to $303,208.51.

Sometime in 1878 all the New York elevated roads were consolidated, and the return for September 30, 1879, shows twenty-three miles of road operated, 46,045,181 passengers carried, and $3,526,825.26 gross earnings. On September 30, 1880, the total mileage was 32, passengers carried 60,831,757, and gross earnings $4,612,975.56. With exactly the same mileage as in 1880, the latest return, for the year ending September 30, 1886, gives a passenger traffic of 115,109,591, and gross receipts of $7,426,216.28; this last statement showing an increase in six years of 54,277,834 passengers carried without any extension of the railway lines.

The daily average of passengers carried in the last fiscal year was 315,369; the greatest number carried in any one day was on June 5, 1886, 557,114. But the management claim that with existing facilities they can daily transport 700,000 passengers. A very remarkable feature of this report is that with a total of 692,929,878 passengers carried on the roads included in this report since 1872, but one person has lost his life, and that from direct personal carelessness. This is a wonderful, an almost accidental, record for a railway line; the same number of people could hardly walk a street without at least some one fatal accident.

As exhibiting the effect of reduced fares, we have a report showing that the average increase in daily travel in the first seven days of October, on the Third Avenue line, was 117,112 over the same period for 1885; and the increase in receipts was $3,489.18 per diem., as compared with the same week of last year.

As a matter of record, the dates of this reduction in fares from ten cents to five cents, are as follows:—On Second and Ninth Avenue lines, June 1, 1886; on Third Avenue line, October 1, and on Sixth Avenue line, November 1, 1886.

Basing our calculations upon what has already happened, the total passenger traffic over these lines within the next few years may reach into the two hundred millions, or very nearly the claimed maximum capacity of the lines. This will mean an almost constant procession of heavier trains and perhaps heavier engines. It is a vitally interesting question, for the passengers, to discuss the possible effect of this constant state of vibration and continued strain upon the fibres of the metal contained in the comparatively light trusses and riveted members. It is hardly necessary to warn the engineers in charge of our elevated structures that a sharp lookout should be kept up over every foot of the line. The work done is already in excess of the wildest dreams of the projectors of the system and it is rapidly increasing; and if theory be correct iron will wear out like any other material under certain conditions of continuous use.

"Big Guns."

The last *Engineering* propounds the following interesting query to English gunmakers:—"where have we afloat to-day one breech-loading armor-piercing gun in a condition fit to fire?"

Our excellent contemporary makes use of the above question in commenting upon the late action of Sir Frederick Bramwell as a member of the Ordnance Committee on the Collingswood's gun failure, and goes on to point out the fact that the English War Office is not only without efficient guns but, more than that, is not even in possession of designs that "combine efficient material with simplicity of form and economy of manufacture." *Engineering* condemns the Committee for experimenting with unannealed tubes in guns when Krupp had demonstrated by years of use that annealed tubes where better. And in general terms accuses that executive body of being very slow to avail itself of the progress made in artillery and materials among other nations.

This is a telling commentary upon the wisdom of our own authorities who are now going to England for steel and, in part, for gun designs. We must again ask the question whether it would not be much better for us to look at home in our new departure in the manufacture of rdnance, and, as in 1861, depend upon our own inventive talent and perfect our own material, if it needs it? At the beginning of our civil war the service suddenly demanded battering guns of great power, and we made guns that eclipsed the artillery of the world in this respect. The guns Rodman

built were of cast-iron, were economical of manufacture and stood service; we now want armor-piercing guns and by replacing the iron with steel, we believe our gun-makers are fully capable of paralleling the success of Rodman. In any event it would be more consistent with the traditions of our old time success to encourage Americans to make the weapons they are sometime to handle.

The Education of Engineers.

The practice of engineering in all its diversified branches has advanced with such rapid strides that the methods of instruction still in use in some of the institutions devoted to the education of our future engineers have fallen below the requisite standard. This is a day of rapid thinking and doing, of vast enterprises and sharp competition in brains as well as material, and the young man who would enter the race must be well equipped to secure a position, somewhere near the front rank. This being the case, the quicker any moss is scraped off from our ideas of class education and the more perfect the organization of to-day is made, the better for our country generally and our young engineers especially.

We notice with pleasure a healthy attempt to discuss this question of reform and the effort made by our more progressive technical schools to meet the requirements of the times; and we feel that the field of this discussion should be widened and would gladly open our pages to any earnest and intelligent suggestions under this head.

In all discussion so far, the generally accepted pre-requisite for the engineering school of the future is a handsome and assured income aside from the fees of students. This is absolutely necessary to eliminate the temptation to fill the institution with pupils and turn out a swarm of graduates regardless of their equipment for an exacting profession.

But with money secured, and all the teaching plant that can be bought with it, the next prime requisite is the executive body with the power, tact and genius to so handle these tools that the greatest good can result.

In too many of our educational institutions the Board of Trustees, is selected with strict reference only to the influence of their honorable names, when employed as bait in catching new students. The Board may not contain the timber within itself to properly fill its executive position nor possess the interest, sympathy and class of knowledge requisite to select the executive who will control in its absence. Boards such as we refer to may be made up of our first citizens, good, intelligent well meaning men, but lacking the qualities referred to they can very soon wreck the school as far as any practical results are concerned. They will do this by meddling in affairs they do not understand; by measuring modern ideas by their own rust-eaten standards; by sacrificing the interests of the institution to gratify personal jealousies, and finally by a lack of wisdom in the selection of the teaching staff. These are grave charges to make, but who, at some time or other, has not seen anyone or all of these charges sustained in certain institutions?

The executive control should be vested in as few hands as possible; the fewer the better if the material is properly selected. The management of such an institution as we would see will demand hard, unremitting labor of a class that can never be obtained from the average Board. And if the trustees can not or will not execute, they should not meddle with those who could and would.

The division of time, classes, course and nature of the studies and general detail of teaching, is a subject we must leave to more familiar hands. But while any institution of this kind is actually a training school which will enable the student to only *commence* the practice of a profession, we owe it to this student to give him as practical an equipment as possible; to send him out into the brambles of this world with a stout suit that will stand wear, not equipped merely in holiday attire, only fit to shine on the rostrum on graduation day. By this we do not mean any sacrifice of theory, but an increase in practice, even if the total course must be longer. And in the studies adopted some discrimination ought to be made between the things that the engineer can use after he leaves the school-room and that which can only be useful as mental gymnastics within the school. For one thing, we will venture to say that seventy-five per cent. of graduates leave their very higher mathematics with their school-books—in the garret. Constant practice is requisite to keep formulæ from rusting and in a condition to use when wanted; and how many of our really busy engineers have the time to devote to this practice? We would by no means seek to belittle the value of mathematical knowledge; but we do think that unless a student shows a special genius in that direction, time is wasted thereon that might better be devoted to something more useful in many particular cases. An eminent engineer, himself educated in the best schools of Europe, one time remarked to us that his time was entirely too valuable to devote it to mathematics, "especially when I can import a figuring machine of excellent quality from Europe for $60 per month." The moral of which is that the most expert mathematicians are not alway the best engineers, or at least cannot secure lucrative practice as such.

Another engineer finds fault with one of our leading institutions, because while it teaches German and French, and even Sanskrit and Anglo-Saxon, it omits Spanish and Portugese entirely from the curriculum for engineers. This is a point well taken, and applies we believe to all of our engineering schools except the Institute of Technology at Boston. There is little probability of American engineers doing professional work in German or French countries, and as for the literature of these lands the best is soon translated into English. But immediately south of us lies a vast Spanish-speaking empire, and further south still is a continent where Spanish and Portugese are the common vernacular. In these sections American engineers have already done good work, and the field of their usefulness could be made much wider by some familiarity with the tongue of the people. Africa too, in which Portugese is the trade language, will also soon present a widening field to progressive American engineers and contractors.

In the methods of teaching, the theory should be as well backed up by *every-day* practice as is possible in an institution of this kind. And, as Prof. J. A. L. Waddell lately pointed out in an address on this subject before the Rensselaer Society of Civil Engineers, the economical side of practice should be especially dwelt upon. It is not enough for a teacher to recommend certain forms of bridge connections, for example, simply because they conform to theoretical requirements for strength; for a practical bridge builder may teach the teacher that other forms are quite as good, and being cheaper and more simple will always have the preference with the man who is to pay for the bridge. As Prof. Waddell further says, it is imperatively necessary that the teacher keeps himself well posted in all new features of practice, in current market prices and new materials and methods of production; otherwise, he will fall behind in a profession that is racing forwards, and his pupils will reflect his own lack of knowledge to their own sore disadvantage.

To the above end teachers of engineering should be live men, old enough to have had a very considerable practice based upon a thorough technical training, and still young enough to be in sympathy with their students and work for and with them. To secure men of the proper character, they must be paid a salary in proportion to the value of their services outside of the school. The late advertisement for "a professor of civil engineering, salary $1,500 per annum," may be in accordance with the present "market price," but that sum will not secure the proper men to educate our future engineers; it is really little better than the pay of an average assistant engineer on construction and we want different timber in our teachers.

The remark of that venerable engineer, Mr. James B. Francis, that "it takes nine pounds of common-sense to apply one pound of science" is an axiom that will apply to boards of trustees in managing their institutions, to teachers in selecting and handling their subjects, and to engineering students, and practicing engineers as well, in applying the matter taught.

Why Is This?

In our late issues we gave tables from the very exhaustive papers of Mr. Edward Bates Dorsey, read before the American Society of Civil Engineers. These tables are so surprising and instructive that by request of many of our readers we continue their publication.

In the two previous tables (Nos. 46 and 49) the comparisons were made between two first-class railroads, probably the most extensive and best equipped of each country. But in order to make the comparisons comprehensive we give below extracts from Mr. Dorsey's papers comparing the cost of operating a first-class English road with a cheaply constructed American railway.

Suppose we substitute in table No. 46 for the Pennsylvania Railroad, the Knoxville branch of the Louisville and Nashville system. This can be considered a fair sample of the cheaply constructed American railroad. It runs through, physically, a very rough, sparsely settled country, offering no natural advantage for cheap railroading. The traffic is so small that it only justifies a total of ten trains daily. The entire average cost of constructing this road is $26,464 per mile—less than one-ninth of the average cost of the London and North Western per mile, and less than two-thirds of the average increase of capital account per mile on English roads from 1870 to 1884.

TABLE NO. 47.

London and North Western Railway, of England, compared to the Knoxville Branch of the Louisville and Nashville System.

1884.	London and North Western.	Knoxville Branch.
Total length of line operated	1 811	171
Total annual freight and passenger train mileage per mile of line operated..	21 086	3 515
Average load of freight trains, tons.....	78	122
Average load of passenger trains, passengers.....	38	30
Average load of all trains, tons and passengers.....	58	86
Average Cost of Transporting one Ton, or One Passenger, One Mile.	**Cents.**	**Cents.**
Maintenance of way.....	.309	.404
Repairs and renewals of locomotives.....	.082	.062
Total cost of motive power.	.271	.230
Total operating expenses...	1.130	1.060

Notwithstanding the small traffic and the cheapness

of construction of the Knoxville Branch, the cost for moving one ton, or one passenger one mile, for maintenance of way, is only .2 cent more, while all the other charges are less than on the London and North Western Railway, the total operating expenses being as 1.130 to 1.069 cents or .061 cent less.

The returns or reports of the London and North Western for 1885 have not been received by me. In 1885 the Knoxville Branch made large savings in the cost of maintenance of way, and consequently in operating expenses, comparing thus:

TABLE NO. 48.

Cost of Moving One Ton, or One Passenger, One Mile.	London and North Western, 1884.	Knoxville Branch. 1885.
Maintenance of way.	.209 cents.	.243 cents.
Total operating expenses.	1.130 "	.819 "

This table shows the cost of maintenance of way to be nearly the same, while the total cost of operating expenses is 27 per cent. less on the cheap than on the expensively constructed road.

This road is built through a very rough country, and owing to its cheap construction the road-bed is undoubtedly rough and trying upon rolling stock.

We again ask our English contemporaries to publish these tables in full, and to ask their engineers to tell us, if they can, how a road so cheaply constructed can be operated cheaper than one costing nearly ten times as much? And also what is the use of spending so much money in construction when a road costing much less is operated cheaper?

We answer this question as we have the others,—it is owing to the superiority of the American rolling stock, especially the locomotive, which costs on a cheap rough road for "repairs and renewals of locomotives" *only 63 per cent. of what it does on the smooth, expensive English road, costing nearly ten times as much per mile to construct.*

The Industries of Pennsylvania.

The annual report, for 1885, on the Industrial Statistics of Pennsylvania, is received. We make note of some of the more generally interesting points, as follows:

The wealth of Pennsylvania in mineral products is proved by the fact that over one-third of the bituminous coal mined in the United States comes from within her borders, and all of the anthracite coal and very nearly all of the coke and petroleum produced is shipped from the same State. One-eighth of the total number of manufacturing establishments in the United States, and one-seventh of the whole number of persons employed in manufacturing, also belong to Pennsylvania.

Glass is an important product of the State; and within it are now thirty-six cylinder glass furnaces producing 1,127,520 boxes of window glass per annum, valued at $2,593,296. With the exception of about 100,000 boxes sent to Mexico, Cuba and Canada, all of this glass is consumed in the United States. For the manufacture of flint-glass table-ware there are now thirty-six furnaces turning out a product annually valued at $4,687,500; this finds a very ready foreign market in Mexico, Cuba, Canada and South America; and were our facilities for foreign commerce more liberal towards manufacturers, it would soon find its way over other portions of the world. Fourteen furnaces are devoted especially to the manufacture of flint-glass, prescription vials and bottles, of an annual value of $1,100,000; the manufacture of lamp-chimneys employs fourteen furnaces, with value produced of $1,610,000 annually. The amount of materials used in glass manufacture in Pennsylvania in one season are, 35,700 tons of soda ash; 95,840 tons of sand; 22,288 tons of lime; 223 tons nitrate of soda, and 25,000 tons of salt. The number of persons employed in this trade is 9,618; and were the total amount of wages paid divided share and share alike, it would amount to $550 per annum.

The report on iron and steel is mainly compiled from the statistical report of Mr. James M. Swank, before noted in this journal. The breweries are classed among the "industries," and are credited with an output of very nearly two millions of barrels, of 31 U. S. gallons each, valued at $13,134,450; whiskey comes in with only 56,044 barrels, valued at $1,100,436.

There are forty-four street-passenger railways in Pennsylvania; employing 4,398 men who receive $2,535,378; this amount paid, divided up equally, would give, each man about $11 per week, for sixteen hours labor daily. On the steam railways 79,210 persons are employed, with wages ranging from $33 to $126 per month.

The recognized area of the anthracite coal fields of Pennsylvania is 470 square miles, and the product shipped in 1885 was 31,623,529 tons; or, including coal used in and about the mines, a total of 34,101,152 tons mined. The number of employés is 100,082 with 196 as an average number of working days in 1885. The report estimates the capital invested in coal mining at about $230,000,000. In the 309 mines operated last year $32,918,642 were paid in wages.

In the bituminous coal fields of western Pennsylvania the output for 1885 was 25,000,000 tons; the sum of $14,240,774 was paid out in wages and divided among 44,006 employés of all grades; this sum distributed share and share alike would give each person employed an average of $27 per month. The report states that the recent introduction of natural gas as a fuel has reduced the coal production by 2,000,000 tons.

The report contains a large amount of statistical matter relating to wages paid, number and class of accidents, the ventilation and working of mines, etc., but it is scattered throughout the many pages of the document in a way that almost defies classification, and no attempt is made at any summation of results. The illustrations, too, are much more ornamental than useful.

Power Distribution by Compressed Air at Birmingham, England.

Engineering, of October 1st, contains an illustrated paper on the use of compressed air as a motive power at Birmingham, England. This paper was read before the mechanical section of the British Association, at Birmingham, and we make from it the following extracts:

The proposition is to distribute power to the amount of 15,000 horse-power; air is to be delivered at a constant pressure of 45 pounds through a system of mains, and from these mains the air will pass through a meter to the various workshops and be delivered at a cost of 5d. per thousand cubic feet. The company has secured Parliamentary power, and is about to put the project into execution; 6,000 horse power has been contracted for.

In the area of 1½ square miles, to which the system is to be applied, about 27 miles of mains will be laid, varying from 24 inches to 7 inches diameter. At the works the coal will be converted into fuel by thirty-two of the Wilson 8-cwt. gas producers, and from these the gas will travel by underground flues to forty-five Lane water-tube boilers arranged in sets of three to each of the fifteen engine-houses. The boilers will be erected between the engine houses, and in each of the latter will be one triple expansion, beam, air-compressing engine, of 1,000 indicated horse-power, driving six single-acting air, compressing cylinders, coupled to the opposite end of the beams, and capable together of delivering 2,000 cubic feet of air per minute at 45 pounds pressure to the square inch above the atmosphere. To feed the boilers and condensers and to cool the air cylinders, 6,000,000 gallons of water will be required per day.

This water will be taken from the canal, and the condensers combine both the surface and jet methods of refrigeration and return 90 per cent. as feed to the boilers, thus avoiding the ill effects of the hard acid water in the canal; they are designed by Mr. A. B. Wilson, of Belfast.

The mains will be of wrought-iron laid in concrete troughs with removable concrete covers, as near to the road surface as possible. At convenient intervals valves will be fixed, so constructed that in case of the bursting of a pipe the rush of air will blow the adjacent valves to their seats and thus shut off the ruptured section of main. These same fixtures also serve as stop-valves, to be closed by hand, and are provided with chambers for collecting and discharging water from the compressed air. Service pipe connections are made at a sleeve-piece inserted at suitable intervals. These wrought-iron mains will be jointed to the valve-casings and connection-pieces by the Forster patent-joint to provide for expansion and contraction, or settlement.

The total capital expenditure for the first 6,000 horse-power is estimated at $750,000, including land, Parliamentary and initial expenses. For 9,000 horse-power, it is estimated that $960,500 will be required; for 12,000 horse-power, $1,172,500, and for 15,000 horse-power, $1,384.000. Mr. Henry Atkinson, is the consulting engineer, and Mr. J. Sturgeon, of 4, Burlington Chambers, New street, Birmingham, is the engineer to the company.

Engine Foundation in "Bituminous Concrete Masonry."

At the meeting of the French Society of Civil Engineers, in Paris on August 6th, M. Leon Malo described a new engine foundation which he had constructed of bituminous concrete, similar in its general features to the one previously built by the same engineer and described in a paper read before the French Society on October 6, 1883. We quote from the bulletin of the *Société des Ingenieurs Civils:*

The advantage claimed for his system of foundations is the absolute suppression of all dangerous or annoying vibrations due to the action of powerful engines and machinery. The foundation about to be described is used for mounting an engine of 100 horse-power, at the Seyssel rock asphalte mines. The foundation-pit for the engine and its fly-wheel, 18 feet in diameter, is excavated from the solid rock; and in this pit was built the asphaltic masonry foundation proper, according to the rules described in Mr. Malo's previous paper. (To quote from a condensed translation of this paper in our issues of November 24th and December 29th, 1883, the process consisted in moulding blocks of asphaltic concrete made by adding pebbles to the melted asphalte; these blocks are then laid up with an asphalte mastic used as mortar. This asphalte mortar is made by reducing the calcareous asphaltic rock to a fine powder and then heating it in a bath of free bitumen (seven or eight of free bitumen to 100 of asphalte) up to a temperature of 230° C. The product is a paste called mastic asphalte, which, when mixed with sharp sand, is introduced into the joints of the masonry as a cement.)

At the Seyssel engine foundation the main mass was 13 by 13 feet, surface measurement, and 4 feet thick; it was built up of roughly pugged blocks of Seyssel asphalte concrete

cemented together as described. This large mass supported the engine proper, its condensers and one of the journals of the fly-wheel shaft, the other journal rested upon a separate block of asphaltic masonry of smaller dimensions. This arrangement and the successful working of the engine proves that while elastic this masonry is reliable, for any deformation in the separate blocks would inevitably cause heating of the shaft journals.

The engine was erected and put to work on July 19th, last; and while it makes seventy-five revolutions per minute, not the slightest vibration can be detected in the masonry base.

PERSONAL

CHARLES EDWARDS, of Portland, Me., who has been connected with the lighthouse service as engineer, architect and superintendent for over twenty years, has resigned his position.

A. L. MENOCAL, Government Engineer, has reported at the Brooklyn Navy-yard for temporary duty in connection with the work of repairing the dry dock.

FRANK W. BOARDMAN, Engineer and Superintendent of the Contra Costa, Cal., water-works since they were first started, has resigned; FRANK BYRNES, his assistant, has been appointed to the position.

JULIUS W. ADAMS, C. E., and WILLIAM. E. WORTHEN, C. E., have been appointed as two of a committee of civil engineers, they to appoint a third, to examine and report upon the Fifth Avenue paving job.

F. W. BALDWIN, late Assistant Superintendent of the Mexican National R.R., at Laredo, Tex., has been appointed Superintendent of the Ogdensburg & Lake Champlain division of the Central Vermont R. R., in place of E. J. CHAMBERLAIN, recently appointed to a similar position on the Canada & Atlantic R. R.

JOSEPH K. SHARP, Assistant Train-Master of the Baltimore & Potomac R. R., died at Washington, D. C., October 7th. He entered the employ of the Northern Central R. R., then known as the Baltimore & Susquehanna, about forty years ago, as freight brakeman, and rose to the position of superintendent.

W. B. PARSONS, JR., the author of "Track" in this journal, has been appointed Chief Engineer of the Fort Worth & Rio Grande R. R., running south-west from Fort Worth, Texas. MR. PARSONS leaves at once to commence construction. He will still retain his connection with the New York District Railway Co.

JOHN E. CHAMBERLAIN, widely known in the Connecticut river valley, died at South Newbury, Vt., October 7th. He was for many years engaged in railroad construction, and was largely interested in the work of building the Boston, Concord and Montreal R. R. from the Connecticut river to the White mountains.

OTTO KLOTZ, Dominion topographical surveyor, is engaged in connecting the British Columbia and North-West systems of survey, and when completed there will be one system of survey from Winnipeg, Man., to Vancouver, B. C., a distance of 1,660 miles, the largest connected survey in the world.

WILLIAM MUIR, for nearly fifty years prominent in marine engineering in England, died recently at the age of eighty-one years. MR. MUIR, since 1839, had been resident engineer to the Cunard Line, at Glasgow, and all the engines of their steamships had been constructed and fitted under his control. From first to last, MR. MUIR was engaged on over 200 vessels of a probable aggregate of not less than 250,000 tons.

PHILIP BECKER, Mayor of Buffalo, N. Y., will resign, according to the Boston *Globe*, on account of the action of the Common Council in refusing to confirm Edward B. Guthrie as deputy city engineer, so that the mayor could suspend Engineer Krause and try him on charges of misconduct in office and neglect of duty.

CAPTAIN A. E. PIORKOWSKI, the foreign representative of Mr. Gruson, of Buckau-Magdeburg, is now in this country on business connected with the introduction of chilled cast-iron turrets for sea-coast defense. The name of Mr. Gruson will be remembered by our readers as that of the inventor and constructor of the chilled cast-iron armor described in Captain Bixby's series of articles on Modern Ordnance published in this ournal last year.

The partnership heretofore existing as the LAWRENCE MACHINE SHOP, have transferred their entire stock, machinery and good will of their business to a new company, formed by the same parties and incorporated under the laws of the State of Massachusetts, October 1, 1886, as the LAWRENCE MACHINE COMPANY, Boston, Mass.

JOS. P. DAVIS, RUDOLPH HERING and ROBERT MOORE, all well known civil engineers, have, according to Providence newspapers, been appointed by the American Society of Civil Engineers a committee to examine and report upon the merits and practicability of the plans proposed by City Engineer Samuel M. Gray for the disposal of the sewage of the city of Providence, R. I.

BENJAMIN JACOB, has been appointed inspector of masonry at the Market street bridge, Philadelphia. The Select Council has approved the following appointments: JAMES D. G. CRAIG, draughtsman in the registry bureau; JOHN R. SCOTT, rodman; EDGAR M. SMEDLEY, chainman; JOHN G. MOORE, sewer inspector.

WILLIAM P. HUNT, proprietor of the South Boston Iron Works, where heavy iron guns are cast, and who has done much to build up this industry in this country, was recently asked by a reporter about the failure of Congress to make appropriations for ordnance; in reply he said "It was the result of a hitch between the Senate and the House over steel guns. General Hawley insisted that provision should be made for 10,000 tons of heavy steel forgings, which at $6,000,000 would enable a steel gun foundry to be started. The House thought it unnecessary and a deadlock resulted, no appropriation being made. I thought the House was right, and recent experiences in Europe have demonstrated that fact. Steel guns have not been sufficiently tested to warrant such an expenditure. They went crazy on steel guns abroad, but within a few months four steel guns on the British man-of-war "Ajax" have been disabled, and orders have been given that no steel guns shall be fired except in actual engagements. Steel guns are breaking up all over Europe. No heavy steel gun has shown satisfactory endurance, and for this reason the proposed expenditure was unwarranted. The opinion of the Ordnance Board appointed by the President does not count for anything, because every member of the board was committed to steel guns before his appointment, and two of them were steel manufacturers."

Proposal for an American Academy of Engineering.*

BY WILLIAM KENT, M. E.

Do we need another Engineering Society? Are not the various American Societies, the Civil Engineers, Mining Engineers, Mechanical Engineers, Sanitary Engineers, Electrical Engineers, the Engineers of the Army and of the Navy, the various local societies in Boston, Philadelphia, Pittsburg, Cleveland, Chicago, St. Louis and other places, and last, but not least, the section of Mechanical Science and Engineering of the American Association enough. What reason is there for the existance of another society?

In 1872 a similar question might have been asked when only one of the above named societies was in existence, the American Society of Civil Engineers. What reason then for the organization of a new society, the Institute of Mining Engineers? But in that year a small group of men organized that society, and it now numbers over 1,400 members. In 1880 another group of men organized the American Society of Mechanical Engineers, and it now numbers 700 members.

All of the other societies above mentioned are also I believe, well and flourishing. In 1882 I attended a meeting of this section at Montreal, when there were only half a dozen members present. We have no need to-day to ask whether this section is flourishing. As far as I know all the Engineering Societies are doing excellent work, and nobly fulfilling the objects of their existence, which objects are chiefly to give opportunities for the members of each society to get acquainted, to mutually diffuse information among themselves, and so to increase the knowledge of all and to increase the already formidable bulk of American Engineering literature. So important are these objects that many engineers find it beneficial to join three or four different societies, and to spend a great deal of time and money attending their meetings.

But with all due respect to all the societies above named, not one of them, nor all together can do the work which I think another society, formed on a different model, ought to do for the benefit of the Engineering profession. I think the time has now come when we should have another society formed in a different way from any now in existence, and with a different object. My scheme is an ambitious one; part of it, if not the whole may be Utopian, but the idea has been growing in my mind for at least two years, getting larger and larger until I think it is time to unburden myself of it, and let some one pull it to pieces if it deserves it, or give form and comeliness to the rough structure as it leaves my hands, if worthy of such treatment.

I look far into the future and I see a Society or Academy of Engineering which shall not be strong in members, not over 300 or 400, but powerful in influence for good, whose members comprise Army and Navy Engineers, Civil, Mining, Metallurgical, Mechanical, Electrical and Sanitary engineers, and are all distinguished men in their respective branches, having *done* something creditable in the engineering line as a pre-requisite to membership. Such membership is the highest honor that can be conferred by the profession upon an American Engineer, except that of officership in the same Academy, and it is an honor that can be conferred only through merit which is appreciated by the majority of the profession, and not through personal favoritism of a nominating committee.

It is an honor moreover which cannot be withheld from a deserving man by a blackball of one, or seven, or even fifty members. It is an aristocracy based upon intellect and achievement, and yet a democracy in which all are equal, in which majorities rule and minorities are represented, in which each member is a representative of a branch society of a lower degree, and owes allegiance to it.

In such society the Army Engineer would lose his caste, and no longer look down on the Civil Engineer, for both he and the Civil Engineer would be promoted to a higher caste; yet the Army Engineer would still be a member of the Army Engineers' Society, and the Civil Engineer a member of the Civil Engineers' Society.

With such an academy in existence, the head of the bureau of engineers of the navy, with a political naval advisory board would not concentrate in themselves all the knowledge necessary to build ships of war, for each would find in the academy other men better posted in ship building than themselves, and would call them in for consultation. The Secretary of the Navy would not need to make a servile copy from the drawings of a Japanese man-of-war for he would find in the academy men who would design a better one. There would be no necessity for a council of engineering societies to organize and agitate for the public works of the Government to be carried on according to the laws of common sense, for the committee on public works of the academy would be charged by the Government to report what works should be undertaken, and members of the academy, some of them army, some navy, some civil, some mechanical engineers, according to the character of the work in hand, would be in responsible charge of them. The honorable member of Congress in whose district is Cheesequake creek would not "log roll" an appropriation for digging out that famous stream, in exchange for a vote in favor of a similar appropriation for some unheard of stream in Minnesota, for Congress would appropriate a round sum to be expended for river improvements under the direction of the academy. The Army Engineers would not condemn a system of harbor improvement, because it was proposed by a civilian, for army and civil engineers would all be friends together in the academy. A mixed civilian and army and navy board would not be appointed to conduct iron and steel tests and be given an appropriation one year, and then be disbanded the next, for the academy would have in charge a series of tests which would run on steadily for ten or twenty years, with an endowment or appropriation sufficient for the work.

I see the academy meeting once a year, one year in Boston, the next in San Francisco, the next in New Orleans, and so on. A whole week is given to business; papers are read and discussed, but they are papers of national importance; they are scrutinized before being printed, and printed before being read. There is no rubbish amongst them. Committees are appointed to carry on investigations, and appropriations are made for their expenses. One committee is instructed to go to Europe and report on sewage and water pollution; another is to report on ordnance and armor for ships of war; another on reclamation of waste lands, irrigation and forestry; another is to conduct experiments on cylinder condensation of engines; another to redetermine the laws of flow of fluids in pipes; another to experiment with the fuels of the United State , and the best methods of burning them; another is to take up and continue the unfinished work of the lamented United States Iron and Steel Board. A medal is presented to one of the members for a distinguished achievement in engineering, an appropriation is made to one of the members to enable him to complete a costly original investigation. A prize is offered for the best paper on a certain subject, and another for an invention which is considered to be of the greatest benefit to mankind.

The academy is rich. It owns a large fireproof building in New York City in which there is the most complete engineering library in the world, and also a

*Read at the Buffalo Meeting of the American Association for the Advancement of Science.

museum of models, plans and photographs of important engineering works, a working laboratory of research for the use of the research committees of the academy and others who may be entitled to it; and a hall for meetings which is used by the Civil, Mining Mechanical and other engineering societies when they meet in New York City.

The academy is interested in the education of the engineers of the future. There is an engineering college with a large endowment in which all branches of engineering are taught, and according to the terms of the endowment one portion of its board of trustees is elected by the academy, and a committee of the academy is entrusted with the allotment of some of its fellowships and scholarships.

The academy is not a venerable body of fossils and old fogies, for it is constantly being enriched by new blood from the several American societies. It is the foremost body of engineers in the world, and the leading engineers of Europe are proud to be admitted to its membership, as the highest honor the engineering profession has to offer them.

Is such a dream impossible of realization. I think not. Three things are necessary for its fulfillment.

1st. The men.

2nd. The organization of these men.

3rd. The money.

The men we have. Some are in the army, some in the navy, some in one society and some in another, but they are not all acquainted with each other, they are scattered over the wide country and never meet together. Glance down the list of names of the Civil and Mining Engineers Societies, and we see names of men of national reputation and great ability who might be shining lights in a congress of societies, but who also from their very attachment to the one society of their choice, are strangers to all the others. What a company these distinguished men would make if they could be organized into one body.

The money would be forthcoming if such a body of men were organized; scarcely a year passes but some millionaire leaves a large sum of money to found some college, hospital, library, art gallery, manual training school, or other institution of public benefit. The American Association has received sums of money to hold in trust for the prosecution of original research. What better disposition of his money could a millionaire make them to endow the American Academy of Engineering with a trust fund to be applied to its several objects, the founding of a library, a museum of engineering, a laboratory for original research, or a scholarship fund for engineering students. Suppose the Academy established and in possession of a working laboratory, would not the National and State Governments be calling upon it frequently for research into questions affecting the public health or safety? And these calls would necessarily be accompanied by liberal appropriations, although this matter of money would be of slow growth. The academy would be poor at first, existing on the fees and contributions of its own members, but money would flow to it as soon as it showed that it had the right men to use the money, and the right kind of organization.

So we have the men and can get the money. How can we get the organization?

My suggestion, which no doubt can be improved upon, is as follows:

Let the question be agitated in the three American Societies, the Civil, the Mining and the Mechanical Engineers, and let them appoint a committee of conference to drew up a plan of organization of the academy. I would suggest to the committee of conference this scheme.

The original members of the academy to be the presidents and past presidents of all the engineering societies of the United States. These men to meet and incorporate the academy. After its nucleus is thus formed it is to grow by accretions of members from the American Societies as follows:

Five members to be chosen each year from each of the large societies, the Civil, Mining and Mechanical Engineers, and two each from the Army Engineers, the Navy Engineers, the Sanitary Engineers and the Electrical Engineers, making twenty-three new members to be added each year. The method of selecting those members is as follows.

Each active member of each society chooses from the whole list of members of his own society, of not less than five years standing, a number of names equal to the number to be elected from his society, thus a member of the Civil Engineers' Society chooses five names, and a member of the Sanitary Engineers Society two names. These he writes upon a ballot which he transmits to the secretary of his own society. Tellers are appointed who select from all the names voted upon those having the highest number of votes, the ten highest from the Civil, Mining and Mechanical Engineers' societies, and the four highest from each of the others. The list of these selected names are then certified to the Secretary of the Academy who prints them in a ballot list, each name having opposite it the number of votes it received in its own society. The members of the academy then vote upon these names by scratching out one half of those nominated by each society. Tellers of the academy are appointed to count these ballots and certify as elected those receiving the highest number of votes, the five highest of those nominated by each of the large societies and the two highest from each of the others. Members elected to the academy have thus to pass through two ordeals, first they must be among the members receiving the highest number of votes in their own societies for the nomination, and second they must be among those receiving the highest number of votes of the members of the academy. There is thus no nominating committee, no council passing upon nominations in secret conclave, and no blackball.

The above is the outline of the scheme. All that I ask for it is a vigorous discussion.

Pumping Machinery in the Anthracite Coal Regions of Pennsylvania

In a paper on the above subject, read by Mr. Howell Green before the American Society of Mechanical Engineers, a few years ago, the following summary of the situation appears, which still holds true to-day:—

"As the pumps now stand in the anthracite coal region, those which use the least fuel are the old plungers, worked by engines on the surface, using cog-wheels and pinions. Next in point of economy are the Bull pumps. Then follow various kinds of steam pumps—good, bad, and indifferent. None use the principle of expansion to a very great degree, and the duty done by 100 pounds of coal may be stated at from 10,000,000 to 20,000,000 pounds of water raised one foot high. * * * When wet seasons come on, the water in the mines gets more troublesome on account of acid which is extracted from the rubbish left in the mines. The water of the mines is not good for use for purposes of condensation, because, when heated to one hundred degrees, it acts on iron with increased force. Fresh water gets more and more scarce, and water is brought long distances by pipes, and often in cars, to supply the boilers; and in some districts good artesian wells are bored. Here, however, another trouble comes in; if the holes go down too deep, the mountain limestone is reached, and lime is more troublesome than sulphuric acid. But by mixing the two together, under intelligent care, a good water is obtained. And so the situation is. The question that to-day troubles the minds of many engineers in the coal regions is, How had we best build our mine pumps—shall we stick to the old method of a plain steam pump, with no expansion or condensation, because it is so handy to put in and take out? So far as the pump alone is concerned, the answer seems, Yes; but when we see the long row of boilers, and immense piles of fuel for them, it calls attention to the other side of the question."

The Subsoil Water of Berlin.

In the "Abstract of Papers," issued by the Institution of Civil Engineers, is a short description of results obtained by Prof. Firkener in seeking for a supply of pure subsoil water for Berlin.

Four trial-wells were sunk and the water drawn was clear and colorless, but on standing for a quarter of an hour the samples exhibited a whitish opalescence and a reddish deposit was formed. After long continued pumpage the percentage of mineral matter in three of the wells increased, chlorine increased in two of them and iron, lime, silicic and sulphuric acid appeared and the amount of oxygen rose and fell.

The author discusses exhaustively the movements of water through homogeneous sand from one confined space to another; the movements of water in natural soil and its movement towards a spring or well in uniform strata and through variable strata. In describing the chemical changes which water undergoes in its passage through soil, he shows that rain-water entering the soil with six cubic centimetres of oxygen to the litre is gradually deprived of its oxygen by the decaying vegetable matter in the superficial layers of soil and absorbs carbonic acid gas. It is thus enabled to attack the debris of the silicates, and dissolves lime, alkalies, and also silicic acid, and with its still remaining oxygen converts the protoxide of iron into peroxide.

As this water sinks lower into the soil it loses all its oxygen, and can now dissolve the protoxide of iron from the silicates; and if it still contains organic matter in solution, it may convert the peroxide of iron into protoxide. The richer it is in carbonic acid the more energetically does it lay hold of the silicates. The carbonic acid is, of course, derived from the oxidization of organic matters, and as these also bring iron into solution, it naturally follows that water which has traversed a soil rich in humus, yields a liquid stronger in protoxide of iron than that passing through sterile soil.

In the same "Abstract" another paper describes the nature of the soil where this search for water for Berlin is being carried on. The bore-holes never exceeded about 80 feet in depth; at 33 feet below the bed of the valley is a layer of water bearing gravel which is overlaid in part by peat-bogs and morass. It was found by analysis that the quantity of peroxide of iron gradually decreased with the depth until it disappeared, while the protoxide of iron increased in like proportion, marking, the author says, the gradual exhaustion of the oxygen in the subsoil water.

In concluding the latter article the author says that the percentage of iron gives rise to the turbidity of water after it is drawn, and as a rule where iron is abundant a considerable quantity of dissolved organic matter is associated with it, due to excess of impurities in the soil beyond its power of oxidization; the coincident presence of sulphuretted hydrogen is sometimes perceptible and even offensive to the smell.

The Importance of Ballast in Maintenance of Permanent Way.*

BY — BURKHARDT.

As a result of experience with iron sleepers increased attention has of late been given to the condition of the ballast.

Lengths of ballast of medium quality, in which wooden sleepers appeared to be dry, have proved unsatisfactory with iron sleepers. By means of their pumping-action the latter draw the wet up from below, and work the ballast up into mud, making a solid bed impossible. This working up into mud occurs also with wooden sleepers, but only after the ballast, having become completely impermeable for water, requires renewing.

The reasons for this difference may be stated as follows:

1. The iron sleeper has twice the deflection of the wooden one.

2. On account of the accurate fastening of the rail to the iron sleeper it shares the whole vertical motion of the rail, whereas with wooden sleepers the play of the foot of the rail in the dogs, and the compressibility of the timber, both tend to lessen the deflection of the sleeper.

3. The hollow body of the iron sleeper is very favorable to the formation of an air-tight cavity, inducing the pumping action above referred to.

4. The under surface of the wooden sleeper lies twice as deep as that of the iron one.

The working up of the ballast into mud by iron sleepers on certain trial lengths has interfered with their more general introduction, whereas the failure should have been put

*Abstracts of Papers; Inst. Civil Engineers.

that in similar ballast there is wet at the bottom of wooden sleepers. These considerations lead to the question: Is enough attention given in Germany to the nature of ballast in the construction and maintenance of railways?

The free-lying ballast introduced by Stephenson on English railways is now the universal rule in Germany; the old German system ("Koffer-system"), or curved-surface system, being entirely superseded; but not only in the form, but also as to the material of the ballast the English chose right at first.

Very little broken stone is used for ballasting German railways, as is shown by the prices of ballast as taken from "Statistics of the Railways of Germany," and given in the following table:—

Date.	Price per cubic yard.		
	Average.	Maximum.	Minimum.
	s. d.	*s. d.*	*s. d.*
1881-2	1 5	4 8	0 3
1882-3	1 5¼	4 7	0 2¾
1883-4	1 5	5 0	0 3

The bulk of the prices range between 9*d.* and 2*s.* 3½*d.* per cubic yard; this shows that there cannot be much broken stone used, the bulk of the ballast being land and river-gravel, sand or cinders. The advantages of the use of broken stone ballast is not as yet appreciated in Germany, the ballast material being chosen on account of cheapness in first cost. The author considers that broken stone is to be preferred to gravel in all cases. Good ballast must fulfill the two following conditions:—

1. It must be capable of being beaten up under the sleeper into a firm mass so as to afford the greatest possible resistance to the deflection when the load comes upon the sleeper, and also the greatest possible resistance to shaking loose.

2. At the same time the material must be such that between the sleepers there may be among it interstices for the passage of water, but also the greatest possible cohesion and friction to prevent slipping, and to distribute equally the pressure of the load.

Broken stone fulfils the conditions in a much higher degree than gravel. There is much more friction between the various angular fragments of the broken stone than between the round pebbles of gravel, and on this account the broken stone when once beaten up retains its place better than the gravel which constantly shakes loose. No doubt a firm bed for the sleeper is more easily obtained in the first instance with gravel as the small stones and sand fill up the interstices between the larger ones, but this is far outweighed by the great advantage of the superior drainage resulting from the use of broken stone.

It is usual in Germany for the ballast to be laid to not more than 10 inches below the underside of the sleepers. With gravel ballast this is too little, as owing to capillary attraction the water stands in the gravel, and also drains off very slowly. The depth should be 12 to 14 inches below the bottom of the sleeper, according to the nature of the formation. Usually no attention is paid to this, the thickness of ballast being uniform throughout, whereas the line stands much better when the formation is permeable than when it is not, however excellent the drainage may be.

The author considers that instead of the ballast being renewed when the line is relaid as is now usually the case, the lower portion of it being then choked with fine matter and impermeable, it should be kept constantly clean by being from time to time opened out and screened, the fine matter being removed, and the coarse replaced, the deficiency being made up with new material. This method would be more in accordance than is the present practice with the principle that ought to guide permanent-way maintenance, namely, that every part of the permanent-way must always be kept in a condition answering to its function, the maintenance being prospective and continuous.

Calorific Value of American Coals.

The calorific value of coals is, of course, an important consideration in the economy steam. In determining which class of coal to burn, the question is by no means only whether its use is adapted to the particular plant; for if other considerations show it to be advantageous from an economic point of view to burn a special class of fuel, it is ordinarily not very difficult or necessarily expensive matter to change the plant to meet this end. Nor is the price of the fuel the sole element entering the question of economy. The cheapest coal to burn is not that which costs least per ton, but that which secures a given required heating or evaporative effect for the least total cost, and so the product of the price and the calorific value of the coal is the true determining comparative element in the selection of the fuel.

Unfortunately the calorific value of our American coals has not been determined accurately and authoritatively within the last forty years, and it would appear to us that their theoretical value, and their actual thermal value in boilers of approved design, would be a fit subject for investigation by competent scientific engineering authority, under the patronage of the Government. But until data furnished in this way are accessible, use must be made of such authority as is at hand.

We are, therefore, glad to find space for the following table, showing the calorific value of American coals, compiled from various sources and presented by the Babcock & Wilcox Company, manufacturers of boilers, in their excellent catalogue on "Steam." The authorities are not cited, but knowing the extraordinary care and ability exercised by Mr. George H. Babcock in the preparation of this latest catalogue, which is in fact an exceedingly useful practical treatise on steam, we feel quite warranted in giving the table considerable credence and commending it to the attention of our readers.

Coal. State.	Coal. Kind of Coal.	Per cent. of Ash.	Theoretical Value in Heat Units.	Theoretical Value in Pounds of Water Evap.
Penn	Anthracite	3.49	14,199	14.70
"	"	6.13	13,535	14.01
"	"	2.99	14,721	14.72
"	Cannel	15.02	13 143	13.60
"	Connellsville	6.50	13,368	13.84
"	Semi-bi'nous	10.77	13,155	13.62
"	Stone's Gas	5.00	14,021	14.51
"	Brown	5.00	14,265	14.76
"	Caking	9.50	12,324	12.75
Kentucky	Youghiogheny	2.75	14,393	14.89
"	Cannel	2.00	15,198	16.76
"	"	14.80	13.360	13.84
"	Lignite	7.00	9,326	9.65
Ill	Bureau Co	5.20	13,025	13.48
"	Mercer Co	5.60	13,123	13.58
"	Montauk	5.50	12,659	13.10
Ind	Block	2.50	13,588	14.38
"	Caking	5.66	14,146	14.64
"	Cannel	6.00	13,097	13.56
Md	Cumberland	13.98	12,226	12.65
Ark	Lignite	5.00	9,215	9.54
Co.	"	9.25	13,562	14.04
"	"	4.50	13 866	14.35
Texas	"	4.50	12.962	13.41
Wash. Ter	"	3.40	11,551	11.96
Penn	Petroleum	....	20,746	21.47

The percentage of ashes appears somewhat small in a few of the coals, notably in Pennsylvania Anthracite, but the figures given represent the best practice. As used in down to the inferiority of the ballast and its impermeability to water. It would be found boilers about 0.8 of the heat units and evaporation named can be practically realized. The relative value of the coals at any special locality may, therefore, be approximately determined by multiplying 0.8 of the price per ton of the fuel at the special locality by the corresponding figures of "heat units," or of "pounds of water evaporated," named in the able. The smallest product, other things being equal, wins the day.

Technischer Verein von New York.

At the annual meeting of the "*Technischer Verein*" (German Technical Society) on October 9th, the following officers were elected:

President: T. H. Muller, Mechanical Engineer.

Vice President: G. W. Wundram, Mechanical Engineer.

Corr. Secretary: H. W. Fabian, Architect.

Prot. Secretary: G. Landsmann, Chemist.

Treasurer: A. Drogmeadt, Mechanical Engineer.

Librarian: H. Bausch, Civil Engineer.

Trustees: A. Kurth, Civil Engineer; P. Gopel, Civil Engineer; A. Sieber, Mechanical Engineer.

The number of members at present is:

Section of Civil Engineers	49
Section of Mechanical Engineers	87
Section of Architects	35
Section of Chemists	32
Total	203

Employers who are in need of assistants will correspond with the Secretary, H. W. Fabian, 705 Broadway, New York City.

CORRESPONDENCE.

The Chicago Exposition.

Special Correspondence.

CHICAGO, October 9, 1886.

The Exposition here seems to be up to the usual standard of excellence this year; and is losing none of its attractive power in drawing large numbers of visitors who are interested in the industrial growth and improvement of the great Northwest. Many of the old time exhibitors have fallen out of the ranks but their spaces are filled with exhibits of equal merit and reflect much credit on firms represented.

The display of machinery is not as large as heretofore but the lack of quantity is amply atoned for in quality. The Cornell Engine Co., 95 and 97 Clark street, Chicago, make a fine showing of their powerful gas engines, which furnish power without boiler, coal, ashes or steam, engineer, fire, smoke, gauges, noise or pumps. The cost of running a 2 H. P. Cornell gas engine is but from 20 to 40 cents per day. Among the other exhibitors may be mentioned the Nye Steam Vacuum Pump Co., 75 Washington street, Chicago, whose pumps are very extensively used throughout the country; the Machinist Supply Co., 216 Lake street, who represent the Ashton Valve Co., of Boston, Mass., and make an excellent showing of their goods; the Clinton Wire Cloth Co., 137 Lake street, works at Clinton, Mass., are extensively represented with their wire goods; Abram Cox Stone Co., 76 Wabash avenue stoves, furnaces and ranges; James B. Clow & Son, Lake and Franklin streets, plumbing material, they are agents for the H. C. Lowrie flushing trap; D. B. Raymond, Dixon, Ill., automatic brick and tile cutter; H. Brewer & Co., of Tecumseh, Mich., have a fine exhibit of clay working machinery, such as tile and brick machines, clay crushers, elevators and pug mills; Fuller Warren & Co., stoves, furnaces and ranges, 56 East Lake street, Chicago, and the Illinois Street-Gas Co., 195 and 197 Michigan street, Chicago, manufacturers of standard street lamps, and contractors for lighting cities by gas or oil: the National Super-heating Gas Light Co., T. H. Osborne, manager, 76 and 78 Fifth avenue, Chicago, introduced Baldwin's electric gas light, which is pronounced by good judges to be a very superior light, and is being used in a large number of prominent buildings in Chicago.

Edw. E. Harbert & Co., 159 La Salle street, Chicago, dealers in telephone supplies, make a fine display of their appliances. Mr. Harbert is the inventor of the "Harbert Acoustic Telephone" which has all the latest improvements in the telephonic line, and is being quite extensively used.

Tower clocks have a good representative in Joseph Barborka, of Iowa City, Iowa, who manufactures regulators, astronomical and tower clocks.

The Art Gallery is given up to American paintings

and water colors this year, and the exhibit is a very creditable one. There are several large canvases by noted American artists, which elicit much favorable comment and admiration. The plaster casts, in the gallery devoted to statuary, have all received a fresh coat of whitewash this year, and make a very presentable and fresh appearance. E.

LITERATURE.

The New Agriculture; or the Waters Led Captive, by A. N. COLE. Illustrated, New York, 1885. *The American Angler*, Publisher.

While this work can hardly be considered as coming under the head of Engineering Literature, the realization of the author's theories on underground irrigation and fertilization would require considerable engineering work. England now has its "Agricultural Engineers," specially educated and trained men who devote themselves to advancing agriculture in all its branches, and we see no reason why such a specific professional class could not do good work here. In his work Mr. Cole details his method, already practically tested, of gathering and conserving the rainfall, etc., in subterranean trenches and thus constantly supplying with needful moisture the roots of trees and plants. His claims seem to be well backed by results obtained.

Topographical Drawing and Sketching, including Applications of Photography. By LIEUT. HENRY A. REED, U. S. Army, Assistant Professor of Drawing, U. S. Military Academy, West Point, N. Y. New York, 1886. John Wiley & Sons, Publishers. Size, 9x11¾ inches, pp. 129; illustrated. Price, $3.50.

This is decidedly the best work of its class that we have ever met with. Lieut. Reed does not neglect the slightest detail, but starts out to make a book that will be serviceable to the novice and at the same time exceedingly useful to those who deem themselves experts. He gives methods from all available and accepted authorities and the reasons for preferring any one of them under certain conditions. Commencing with the draughting material and instruments and their selection and proper care, he then passes on to their use, from the sharpening of the pencil to the finishing touches on the work. The chapters devoted to the configurations of surface of the ground and hill-shading by pen or by brush are both interesting and clear in explanation and illustration. The copying and enlargement, or reduction of maps, topographical sketching, and the application of photography to topographical sketching are well explained. In a word, the book is an invaluable one to all ambitious of doing good work in this direction.

Elements of Geodesy. By T. HOWARD GORE, B. S. Professor of Mathematics in the Columbian University; sometime Astronomer and Topograher U. S., Geological Survey; Acting Assistant U.S. Coast and Geodetic Survey; Associate des Preussischen Geodätischen Institutes. John Wiley & Sons, Publishers: New York, 1886. Size, 6x9 in. pp. 282, Price. $2.50.

The author commences this work with an interesting historical sketch of geodetic operations; from Pythogras, and "camel steps" used in measuring a base line, to the latest refinements of modern science. He then describes the instruments and methods of observation, adjustment, use, etc. Chapter III is devoted to base measurements; giving, with illustrations, what are accepted as the best methods together with examples. Chapter IV relates to the field-work of the triangulation; the adaptation of the work to the face of the country; the signals, etc. The remaining chapter embrace the mathematics of geodesy, entering very fully into the theory of least squares, calculation of the triangles, geodetic latitudes, longitudes and azimuths and the figure of the earth. An appendix contains a set of formulæ and factors useful in workof this kind. Mr. Gore has undoubtedly carried out his expressed and chief purpose of here putting into a handy and accessible shape a vast amount of information valuable to the engineer interested in geodetic operations.

Mechanics of the Girder: by JOHN DAVENPORT CREHORE, C. E.; New York, John Wiley & Sons. 8 vo. pp. 575. $5.00

The aim of the author in writing this volume will be clearly seen from its sub-title—"A treatise on bridges and roofs, in which the necessary and sufficient weight of the structure is calculated not assumed; and the number of panels and height of girder that render the bridge weight least, for a given span, live load, and wind pressure, are determined." Single span trusses alone are discussed.

From the preliminary chapters which deal with the elementary principles of statics, and from that which treats of the flexure of beams, one might infer that the work was designed to be used by those who were attempting for the first time to master the methods of truss analyis; but the author so soon plunges into intricate investigations, broadly generalized, that the text quickly becomes very solid reading. One ought to possess a good knowledge of the more common methods of handling the subject to easily follow the treatment used here, and to appreciate the results deduced. A bridge engineer who has not, through the long use of the simpler and routine computations of the drafting-room, become too] rusty in the methods of higher mathematical analysis, will find many points of interest brought out by the comparison of different types of truss.

He first takes up a girder in its most generalized form, where all the members, both chord and web, are inclined at various angles to the horizon, and deduces general equations, in terms of the bending moments and the difference of bending moments at successive joints, and then proceeds to classify and analyze trusses according to the form which these equations assume when particular values are assigned to one or more of their variables. By the interpretation of the significance of algebraic formulas of a somewhat involved character, the action of loads variously distributed, and the economical height and panel length of the several trusses are shown.

Such a method of analysis does not appear to be the easiest for one new to the matter to master, if it is so for a reader better informed on the general subject. The treatment of a class of problems in their general form, followed by the solution of special cases, is the most comprehensive and scientific; but a presentation of a concrete example, followed by an abstract discussion, enables a student new to the work to apprehend better what the author has in view.

With the distribution of load here taken, and the assumptions of proportion and weight of parts and of cost of materials and labor, the deductions as to economical number of panels and height of truss naturally follow; but we doubt whether it is possible to bring all the items involved in the cost of bridge construction with the rigid grasp of an algebraic expression, to be differentiated for maximum and minimum. It is a question whether the accepted theories are sufficiently close to the truth to make great refinement useful in attaining results. Apparent exactness of computation may sometimes mislead.

In the discussions of beams and columns, we were disappointed to find nothing in advance of books already published, and we had hoped to see the fact pointed out, that it is unreasonable to expect experiments on columns as well as beams, when carried to the point of failure of the piece, to give results agreeing with formulas derived on the hypothesis of a uniformly varying stress. Such an hypothesis, while reasonably exact within the elastic limit, and consequently applicable to all engineering structures, probably ceases to be true above that limit, and departs from the truth very widely when the member is about to fail.

As the book pertains strictly to the *mechanics* of the girder, no discussion of joints and details is entered into. The author died two years ago, and the volume closes somewhat abruptly; but the general treatment is complete, and enough examples are given to make the application of it clear. The book represents a vast amount of labor in analysis and computation.

FINANCIAL.

(Special).

NEW YORK, October 12.

A scheme is on foot now backed by prominent and influential capitalists, looking to the introduction of dealings upon the Stock Exchange, in the securities of a company that has been formed to supply natural gas for lighting and heating purposes. The governors of the Stock Exchange have not yet passed upon the application to have this company's stock put upon its regular list, but the backers of the enterprise including Westinghouse, the famous air-brake man, and other similarly strong capitalists are confident that the Stock Exchange will not long hesitate about admitting their securities to dealings.

Again and again the Standard Oil Company has sought to get its certificates put upon the Stock Exchange lists for regular dealings, but despite their financial consequence Mr. Rockfeller and his associates have uniformly been refused the recognition they have asked of the Stock Exchange governors.

It has been held that oil would be too dangerous in its wide and sudden fluctuations to permit of safe transactions. It has been kept off the lists simply to protect the Stock Exchange brokers who might not be able to manage their accounts rapidly enough to keep pace with the pell mell rush of the quotations up and down.

It would seem that all the objections that may be urged against dealings in oil, might quite as strongly be brought against dealings in natural gas. Yet it is certain that the promotors of this enterprise are very confident that they are to get recognition from the exchange; if they de secure this, Wall street will have the opportunity to indulge in one of the prettiest and liviest gambles ever known. A broker who stands very close to Westinghouse, tells your correspondent that there will be from 50 to 100 per cent. profit in the company's stock as soon as it is listed. The company is already earning it is claimed at the rate of 10 or 12 per cent. and is yet "hardly under way."

Wall street has not heard much of this proposed enterprise, so closely has the secret been kept and there is likely to be no publication of the project before this appears in your columns. It will pay every one your readers who has any interest in Wall street activity to watch what follows if they do not like to take risks—and there will be risks and mighty big ones—they at least will be able to get an exceedingly interesting text for reminiscences if, as Mr. Westinghouse expects, the securities are really listed.

There is no where in Wall street just now discernible anything but a conservative bull sentiments in certain stock, some of them having lately been conspicuous in having market rises and have within the past few days been let down somewhat This has been so in Reading notably. It is fairly safe to predict however that if the present expectations of big men in Wall street are to realized, Reading now selling in the vicinity of 33¾ will reach something like 40 before Saturday night. Jersey Central just lately had a set back but is promised a rise of more or less consequence too.

All the Vanderbilt stocks are strong just now, most of them standing at present at the highest point of the year. There seems to be something of consequence in progress behind the scenes touching Lake Shore's relation to the Nickel Plate property. This sometning is apparently to be of decided value to both Lake Shore and the Nickel Plate. The latter securities seem to be in good advances, both the stock aud bonds.

Canadian Pacific is backed by a big speculative pool on the Stock Exchange just now, and one enthusiastic millionaire who has been a big purchaser of the stock during the past fortnight, has wagered a big sum of money that within the next twelve months Canadian Pacific will have risen twenty points or more, crossed Lake Shore and be a much bigger temptation to investors than now.

The Vanderbilt "boys" sent one of their representatives to Wall street yesterday and new accounts have been opened upon the bull side of stocks for the account of the Grand Central party.

Manufacturers all over the country report business booming, and merchants now in this city from various parts of the Union say that trade has not been so brisk and profitable at any time since 1880.

Scrapers and Wheelbarrows.

My observations during the past two seasons, in comparing the value of wheelbarrow and scraper work on levees leads me to give a very decided preference to the scraper. It is compact and solid, holds its elevation well and preserves its slopes. Occasionally in very light material the scraper work suffers from rain wash on the surface, but one redressing is generally sufficient to cure the evil. In wheelbarrow work, especially by station men, now the universal method of doing it, the grade line is undulating after subsidence, and the structure very porous, giving rise to sloughing in high water.

I had thought of offering a premium on scraper work in future operations, or a discount on wheelbarrow work, which amounts to the same thing, by announcing to bidders that their proposals will be coustrued to meen scraper work, and if done with wheelbarrows the price paid will be one and a half cents per cubic yard less than the price bid. As this is a somewhat radical innovation on prevailing custom, I submit the suggestion for the consideration of the Board.—G. Y. Dubney, Chief Engineer Levee Commission for Yazoo, Miss., Delta.

WATER

THE WATER BILL CHESTNUT.—Butte's water supply is getting short again, but the same old bills will be presented on the first of the month. The consumers have to pay for the water whether they get it or not. Butte, Mont., *Inter-Mountain*.

MOUNT VERNON, (N. Y.) WATER.—There has been much complaint at the quality of water supplied by the water-works company. Dr. Brush, the Health Officer, has analysed the water and reported it unfit for use.

CORRY, PA.—The new water-works have been completed and were formally accepted by the Council on the 7th inst. There are two reservoirs, one on Hare creek, capacity 20,000,000 gallons, and one on Spring street hill, capacity 4,000,000 gallons; 8 5-8 miles of

12-inch pipe and over 60 hydrants, the pressure on which is from 60 to 120 pounds. There are two Holly pumping engines of 2,000,000 gallons capacity each: the boilers were made at the Corry City Iron Works. The engine house is of brick, 30 by 50 feet with a smoke-stack 67 feet high. The tests were entirely satisfactory, streams being thrown over 100 feet vertically and from 160 to 195 horizontally; all these tests being made with the pressure from the reservoir; with the pumps it is claimed that water can be thrown 30 feet higher. Ellis Morrison was the engineer-in-chief and George C. Stevens, the assistant engineer: the contractors were Samuel R. Bullock & Co., of New York City, who commenced actual work in June last; the thanks of the Council were tendered to the engineers and contractors. The cost of the works has been $105,000. The officers of the water company are: President, Hon I. B. Brown; Treasurer, E. Waltman; Secretary, Ellis Morrison.

COHASSET, MASS.—A party of about 35 members of the Boston Society of Civil Engineers inspected the new water works system on the 9th inst., visiting the pumping station, reservoirs and the series of 65 artesian wells from which the supply is obtained. The works were described by the constructing engineers, M. M Tidd, of Boston, and Daniel N. Tower, of Cohasset.

NIAGARA RIVER HYDRAULIC TUNNEL, POWER AND SEWER CO.—The Secretary reports that many applications are being made for power, and enquiries made as to when the tunnel will be completed, showing that there will be a demand for the power as soon as it is made available.

LATROBE, PA.—The new water-works are nearly completed. They are on the Holly system, capacity 2,500,000 gallons daily; the supply is taken from Layalhanna creek and flows by gravity through a filtering arrangement into the well, one mile from the town, whence it is pumped into the mains, which have a length of four miles. The stockholders are: A. W. Mellon, of Pittsburg; W. A. Showalter, Dr. H. L. Donnelly, Martin Bossart, and others.

SEWERAGE FOR THE CITY OF MEXICO.—President Diaz has decided upon a system of sewerage for the capital city, the death rate of which is very high owing to the bad sanitary condition of the city. Roberto Mayall, the city engineer, has recently visited Memphis, Tenn., and Pullman, Ill., to investigate the Waring system of sewers in operation there. It is stated that this system will be adopted, and that $6,000,000 will be expended on the work, of which $3,500,000 will be spent in driving a tunnel six miles long through the mountain, and in constructing a canal from the city to the tunnel, a distance of 30 miles, for the conveyance of the sewage.

ORANGE, N. J.—The question of water supply remains unsettled, and has been complicated by the addition of a proposal to introduce a system of sewerage. At the last meeting of the Special Water Committee, John A. Nugent attacked the syndicate that proposes to erect water-works, quoted statistics to show that while the syndicate wants to charge $50 per hydrant, in other places of the same population the charges ranged from $2.50 to $25 or $30; he also stated that the New Jersey Water Co. would soon be prepared to furnish all the towns in the vicinity. After some excited debate a resolution presented by Mr. Nugent that the Board of Trustees continue the work of investigation into the water question, to consider the necessity of drainage and sewerage and employ experts if necessary, was adopted and the Board of Trustees notified to that effect.

COLLAPSE OF A STAND-PIPE.—The King's County (N. Y.) Water Co. recently completed its new water tower at Sheepshead Bay, L. I., it was 250 feet high, 16 feet diameter at the base and 8 feet at the top, resting on a brick foundation; was built of steel plates from 1 inch to ⅜-inch thick, and weighed about 200 tons. Wire rope guys were used to steady it. It was supposed to resist a pressure of 60,000 pounds per square inch, and on the 7th inst. it was tested; when the column of water reached the height of 227 feet one of the lower plates burst, and as the water gushed out the tower broke in several places and fell to the ground, Mr. Robinson, who was conducting the test, escaping with a thorough drenching. The loss will be about $25,000 and will fall on the builders and steel plate makers as the tower had not been formally accepted. The plates were furnished by Schoenberger & Co., of Pittsburg, and were put together by the Robinson Boiler Works, of Boston. Mr. Robinson, it is stated, rejected a good many plates on account of bad quality.

WATER-WORKS FOR FLORIDA.—A. A. Parker, of the Huntingdon (Pa.) Water Co., will put in water-works at Eustis, Orlando and De Land, Florida. The systems will be both direct pumping and stand-pipe. The water will be taken from lakes and is of good quality, but will be filtered to remove animal and vegetable impurities. The mains will be from 4-inch to 10-inch diameter, and will be large enough to provide for future growth and to furnish an ample supply for fire protection and all purposes. Special attention will be paid to irrigation, for which purpose the water will be measured by meter and charged for at the rate of 35 cents per 1,000 gallons. Manufacturers of filters are requested to address A. A. Parker, Eustis, Fla.

PLAINFIELD, N. J.—The Lamps Committee of the Council has consulted with an engineer with reference to the cost of making a survey of the city. Their report is as follows: "Your committee had an interview with Mr. Bassett, Consulting Engineer of the City of Newark who is both a civil and sanitary engineer. He is willing for the sum of $600 to make a careful survey of the streets as now laid out—about sixty miles—the alignments and grades, and make maps of the same showing on a suitable scale general plans of a water and sewerage system separately, with the locations of the source of supply, the reservoirs and the sewage depository. Also make a general written report of the local conditions, its difficulties and broader details. In addition to the sum mentioned the city would have to be responsible for all wells driven as tests, and for any analysis that might be made at the instance of the committee having the matter in hand. We are informed the cost of average analysis would be from ten to fifteen dollars for each."

A resolution that Mr. C. P. Bassett be employed to make a survey and report on a system of water-works and sewerage was tabled, and Mr. Bassett made some remarks in explanation of the advantages of such works to a city.

NEWS OF THE WEEK.

Contracting.

Cast-Iron Pipe. (Correction).—The contract for pipe announced in our last issue (page 239) was awarded to the Cincinnati & Newport Iron and Pipe Co., and not to the Ohio Pipe Co., as there mentioned.

Sewers.—At Philadelphia, Pa., contracts for sewers have been awarded as follows: John M. Mack, $2.50 per lineal foot; and David Ryan, $2.23 per lineal foot.

Masonry.—The contract for stone work and retaining walls for the new canal bridge at Defiance, O., has been awarded to Mr. Karst at $7.60 per cubic yard.

Curbing and Paving.—The Comptroller of New Orleans, La., has received the following bids for the curbing and paving of a brick sidewalk: M. Cooney, $1.84 per lineal foot; and T. J. Coleman, $1.50.

Levee.—The following bids for the Morganza levee have been received by the Louisiana Board of State Engineers: P. Harnan, 28 cents per cubic yard; P. J. Trezevant, 25 cents; M. O'Malley, 24.75 cents.

Dredging and Stone.—The following bids for dredging in the Delaware river at Smith's Island Bar, were opened October 12th by Lieut. Col. Henry M. Robert: Frank C. Somers, Philadelphia, Pa., 21 cents per cubic yard; National Dredging Co., Wilmington, Del., 24 cents; W. H. W. Morris, New York City, 20.5 cents; American Dredging Co., Philadelphia, Pa., (awarded the contract) 18 cents.

For furnishing and placing stone in the revetment, bids were as follows: S. B. & E. W. Twining, Yardley, Pa., $2.00 per cubic yard; Wm. M. Field, Kentmere, Del., $1.35; John A. Bouker, New York City, (awarded the contract) $1.33; Charles N. Vollum, Philadelphia, Pa., $1.33½.

Asphalt Paving.—The Barber Asphalt Paving Co. and the Western Asphalt Co., are having a close fight in St. Joseph, Mo. 11,000 square yards of paving are to be let, and the Western Co. bids $2.61 and the Barber Co., $1.25 per square yard. The Omaha *Bee*, from which we copy this item, says that Omaha has paid the Western Co. about $700,000 for paving, and figures out a handsome profit to the aforesaid company at the prices paid.

Dredging Contracts.—The contract for dredging in the harbor at Newport, R. I., has been awarded to the Hartford Dredging Co., at 21¾ cents per cubic yard. The total amount of the contract is $13,000.

The lowest bidder for dredging in the Potomac river was Frank C. Somers; his price was 10⅝ cents per cubic yard in place, or 22.9 cents in the scow. Bids for rip-rap stone for the river improvement were: J. Vanderwerten, 83 cents per cubic yard; Henry P. Gilbert, 84 cents.

Excavation.—The following bids have been received by the Streets Committee, Wilmington, Del.: For 2,860 cubic yards; James F. McBride, 41 cents; Patrick Carberry, 33 cents; Walter McEvilley, 30 cents; John Logue, 26.5 cents; J. McLaughlin, 24.5 cents; Wm. O'Meara, 23 cents; Martin Keogh, Jr., 12.75 cents. For 1,760 cubic yards, James J. McBride, 37 cents; M. Keogh, Jr., 29 cents; J. Logue, 28 cents; P. Carberry, 25 cents; W. McEvilley, 24.5 cents; Wm. O'Meara, 28.75 cents.

Railroads, Bridges and Canals.

The Charge of the Track Brigade:

"Half a mile, half a mile, half a mile further!"
Went "The Half Hundred!"
Men who were laying track,
Without time to look back,
While the dropping steel thundered
"Cuts" to the right of them,
"Fills" in front of them.
A mule pulling hard in the collar,
Theirs but to lift and cry
"Down!" Not to reason why,
If they got the almighty dollar.

Thirty feet, thirty feet, thirty feet more.
"Down!" They stepped the paces,
Not fearing leaden hail,
Gripping fast a steel rail,
Each one being dropped in their places.
Breakfast behind them,
Dinner in front of them.
Hunger pulling hard at their vitals:
Theirs not to retreat,
Theirs but to work and eat,
Not a man of them bearing titles.

—[S. S. F. in Conductors' Monthly.

The Kentucky Central Bridge is commenced at the Covington side of the Ohio river. The south caisson is now being sunk to a depth of 60 feet. The pneumatic work is being done by Gen. Wm. Sooysmith & Son. Charles Sooysmith being in direct charge. The Cincinnati *Telegram* quotes the cost of the piers and foundations at $600,000.

Philadelphia Underground Railroad.—The Metropolitan Railroad Co. has been incorporated to run from Upper Darby, through the city to Chelten Hills, a distance of 15 miles. President, Wm. A. Ingham, President of the East Broad Top R. R. and other companies; Treasurer, George G. White, Secretary of the Phœnixville Iron Co. Capital stock, $2,225,000. The tunnel will be 15 feet 6 inches deep; and trains can be run at a speed of 30 miles per hour; motors are to be used which are free from smoke, gas and cinders.

Norwegian Railroads.—Norway has a railroad system of 970 miles, 602 miles of which are of 3 feet gauge, and the entire system, with the exception of 42 miles, is operated by the Government. The total cost for the construction and equipment of this system was $31,566,690, or $32,536 per mile. The railroad between Uleaborg and the south of Finland—the North of Europe R. R.—is now completed and is expected to assist greatly in the development of Finland. This line is the most northerly railroad in the world, reaching to within 1¾ degrees of the Arctic circle.

Hudson Bay R. R.—The starting point at Winnipeg has been decided upon and a corps of engineers commenced the location on the 6th inst.: the route will be by way of Oak Point, Lake Manitoba and thence to Hudson Bay. Forty or fifty miles are to be built this year, and steel rails for sixty miles have been purchased. Contracts have been awarded to Mann & Holt, Manitoba section, and McClellan & Grant, Hudson Bay section. The sub-contractors are: Eagan Bros., Crookston, Minn.; George Strevel; Gillespie & Sinclair, Cameron Bros., Goodman & Newton, Keith Ross and A. McLeod, of Winnipeg, and McKinney Bros., of St. Boniface. The privilege to receive 90 per cent. refund of duty upon horses, oxen and mules that was granted to the contractors of the Canadian Pacific R. R., will be accorded to the Hudson Bay R. R. contractors. Mr. Kirby has resigned his position of Secretary to the company and Mr. Lawrence Clark has been appointed in his place.

Europe's Highest Observatory.—In the heart of the Province of Salzburg, on the Sonnblick, which rises to a height of 10,177 feet, a great meteorological observatory, the highest in Europe, has just been erected, which will be in immediate communication with the central Meteorological Office at Vienna. The walls are over a metre thick. Telephonic communication has been established from the summit of the mountain across the Goldberg glacier, down into the Rauris valley, and when the telegraph wires will have been extended from Taxenbach the communication will be complete. The view from the summit is magnificent, ranging over a great part of the Tyrol, Carinthia, and Salzburg. The roof is of copper, chiefly on account of its electrical advantages. The situation is very exposed, and is a sort of center for the discharge of electrical disturbances. There were many opportunities of watching the behavior of lightning during the erection of the building. Dr. Hann, the Director of the Central Meteorological Institute at Vienna, has superintended all the arrangements. The observatory will be thoroughly equipped, and it is expected that by the 1st of September it will be in working order.—London (Eng.) *Times*.

Contractors Intelligence,

Reported by T. H. Boorman.

Engineering and Building Materials.

WHOLESALE PRICES.

New York, October 14, 1886.

IRON.

STRUCTURAL IRON.			
Angles	2.15c	@	2.30c
" steel	2.40	@	2.50
Tees	2.50	@	2.60
Beams and channels, American	3.00	@	
Tank plates	2.25	@	2.35
Shell plates	2.50	@	2.60
Steel plates, Tank	2.70	@	2.75
WROUGHT-IRON PIPE. PITTSBURG.			
Butt welded, black ..... Discount			42½
" " galvanized ..... "			32½
Lap welded, black ..... "			55
" galvanized ..... "			37½
Boiler tubes			47½
RAILS.			
Steel (large lots at mill)	$34.00	@	$35.00
Old rails	21.00	@	21.50
Old rails, steel	22.00	@	23.00
R R. spikes	2.15c	@	2.25c
R R. splice-plates	1.75	@	1.90
R R. track bolts, square nuts	2.50	@	2.75
Barb-wire fencing, galvanized	3.85	@	3.90
" painted			4.00
Corrugated iron			
Nails			
Iron, per keg	2.00	@	2.10
Steel do.	2.10	@	2.20

METALS.

COPPER.			
Lake Superior	11.12		
Other Brands	11.05	@	11.45
LEAD.			
Com. Domestic	4.30	@	4.35
Lead Pipe	.06¼c.		
Tin-Lined Lead Pipe	.15		
Sheet Lead	.07¼		
ZINC.			
Sheet	5.60	@	5.70

BRICK.

Cargoes (afloat)			
Choice Brands	7.62½		
Haverstraw ..... per M.	6.75	@	7.62½
Fishkill	6.75	@	7.25
Up-River	6.50	@	7.00
Jerseys	6.00	@	7.00
Long Island			
Pale	4.50	@	5.00
FRONTS.			
Croton, red	11.00	@	15.00
" dark	11.00	@	15.00
" brown	10.00	@	14.00
Philadelphia pressed	27.00	@	28.00
Trenton "	25.00	@	26.00
Baltimore "	37.00	@	41.00
Buff "	33.00	@	35.00
Enameled English	85.00	@	130.00
" American	80.00	@	120.00
Fire brick	25.00	@	55.00
" American, No. 1	30.00	@	35.00
" " No. 2	25.00	@	30.00

ASPHALT.

ROCK.			
French, per ton	$20.00	@	25.00
German	15.00	@	20.00
According to quantity or brand, and whether taken from vessel or store.			
PAVEMENT.			
Barber's Asphalt	$2.50	@	$3.00

LIME.

Rocklock Cement Co.'s Ground	.80
Rockland, common per bbl	1.00
" finishing	1.20
State, common	.85
" finishing	1.05
Kingston, ground	.90
Add 25c. to above figures for yard rates.	

STONE.

Cargo rates at New York.

Amherst freestone, No. 1 per cub. ft.	0.95	@	1.00
" " No. 2 "	0.75	@	0.85
" " light drab "	0.80	@	0.95
Berlin " in rough "	0.75	@	1.00
Berea " " "			
Brown stone, Portland, Ct. "	1.00	@	1.35
" Belleville, N. J. "	0.75	@	1.35
Granite, rough	0.45	@	1.25
Common building stone per load	2.00	@	3.00
se stone, from 2½ to 6 ft. lengths, per lin. ft.	0.40	@	3.00
oncrete and macadam stone, Tomkins Cove, per cub. yd			$1.65

SLATE.

Purple roofing per square	6.00	@	7.00
Green "	6.00	@	7.00
Red "	15.00		
Black Penna. (at New York) "	4.50	@	5.00

LUMBER.

Prices for yard delivery in New York.

PINE, Common box per M.	18.00	@	20.00
Choice "	65.00	@	70.00
Tally plank, 1¼ in. 10 in. dres'd. each.	.44	@	.50
Tally boards, dressed com. "	.28	@	.30
SPRUCE, Boards dressed "	.25	@	.28
Plank, 1¼ in "	.28	@	.30
" 2 in. "	.38	@	.40
2 in. dressed "	.43	@	.45
Timber per M.	14.00	@	18.00
HEMLOCK, Boards each.	.18	@	.20
Joist, 2¼ × 4 to 4 × 6 in	.16	@	.44
OAK per M.	55.00	@	65.00
CYPRESS 1, 1¼, 2 and 2¼ in "	35.00	@	40.00
YELLOW PINE, Girders "	25.00	@	30.00
Dressed flooring "	28.00	@	35.00
SHINGLES, Extra shaved pine, 16in. "			
" sawed 18 in. "	5.75	@	6.00
LATH, Cargo rate "	2.35	@	2.40

PAINT.

Lead, white, American dry per lb	.04¾	@	.06¼
" " in oil pure "	.07	@	.07¾
" English, B. B. in oil "	.06¾	@	.08¾
" Red, American "	.06¾	@	.07
Litharge "	05¾	@	.06
Venetian red, American "	.01	@	.01¼
Indian red "	.08	@	.10
Vermillion, American lead "	.10¾	@	.11¾
Paris green "	.15	@	.18
Umber, Amer. raw and powdered per lb.	.01¾	@	.01¾
Drop black, Amer.	.07	@	.13
" " Eng.	.11	@	.13
Chrome green	.10	@	.25
Oxide zinc, American	.03¾	@	.03¾
" French	.05½	@	.07½

CEMENT.

The following price current is made up entirely from quotations furnished us directly by the firms dealing in each brand; the prices are understood to be wholesale in New York, subject to such special rates as large quantities may warrant:

CALVIN TOMKINS:			
"Old Newark Co's." Cement			$1.10
BAETJER & MEYERSTEIN:			
Hanover Port.and	$2.60	@	$2.65
BELLONI & Co.:			
Hemmoor "Crown" brand			2.50
JAMES BRAND:			
Burham	2.25	@	2.50
Fowen	2.25	@	2.50
BROOKS, SHOOBRIDGE & Co.	2.45	@	2.60
FISHER, ERSKINE W.:			
Stettin (German) Portland Cement	2.40	@	2.75
HOWARD-FLEMING:			
Gibbs' English Portland, 400 lbs	2.50	@	2.75
K. B. & S. " "	2.25	@	2.50
Stettiner, German	2.65	@	2.85
Lagerdorfer, "	2.45	@	2.75
Fieve, A 1, Belgian	2.35	@	2.50
Roman	2.75	@	3.00
Keene's Coarse	4.75	@	5.50
" Fine	7.75	@	8.50
" Superfine	8.50	@	10.00
HUDSON RIVER CEMENT CO. Rosendale			0
JOHNSON & WILSON:			
Saylor's American Portland	2.15	@	2.45
LESLEY & TRINKLE, Philadelphia, Pa.:			
"Giant" Portland	2.20	@	2.40
Improved "Union"	1.25	@	1.50
Union	1.10	@	1.20
NEW YORK CEMENT CO.:			
Rosendale			1.10
N. Y. & ROSENDALE CEMENT CO.:			
Rosendale, "Bridge" brand			1.10
SINCLAIR & BAUSON:			
Alsen's Portland Cement Works	2.35	@	2.85
K. B. & S.	2.25	@	2.50
STANDARD CEMENT CO			
E. THIELE:			
Dyckerhoff	2.90	@	3.25
UNITED STATES CEMENT CO.:			
English Portland	2.25	@	2.40
German "	2.00	@	2.15
Standard	1.50	@	1.65
Windsor and Improved Rosendale	1.00	@	1.10
UNION AKRON CEMENT CO.:			
Akron "Star" brand	1.00	@	1.10

MARKET SUMMARY.

The long continuance of fine weather has enabled contractors to accomplish a great amount of work, and the supply of building materials has been extensively drawn on, the demand has stiffened prices generally, and manufacturers report difficulty in getting their products on the market as fast as required. Brick is in request at advanced rates, Pale fetching $4.50@$5.00 per M, Jerseys, $6.00@$6.75. Up Rivers, $6.50@$7.00. Fishkill in request at $6.75@$7.25. Haverstraws $6.75@7.25 for seconds, $7.25@$7.62½ for firsts; fronts sell readily at last quotations. Rosendale cement is in excellent demand, and first quality brands easily sell at $1.10 per barrel, with some makes not so well known at $1.00 per barrel. Lime hardly arrives fast enough to suit consumers, prices remain as last quoted. Portland cement continues to meet with ready sale, and difficulty is experienced in obtaining special brands. The demand for Plaster and Hair continues good, without changes in quotations. In the Lumber market no changes in quotations are reported, a good business is being transacted at last weeks rates. Lath continues to command $2.35@$2.40 per M with arrivals not amounting to consumers requirements. The Hardware market continues to show little activity, although there seems to be a little better feeling. Nails are in moderate demand with prices quoted at $2.00 to $2.10 for 10d to 60d, with reports of breaks even in the lower figure for car lots. Lead shows a stiffening in figures, common domestic sold at 4.35c. and foreign, at 4.40@4.45c. ex store. Tin is about as last week, and Tin Plates also show little variation in figures. The Paint and Oil markets are steady at late quotations, with Turpentine again weaker, 37c. being full value. We notice an advance on Wrought-Iron Pipe, the new discounts are as follows: Plain ⅛-inch and under, 40 per cent.; do. ⅛-inch and over, 52½ per cent.; Extra Heavy ⅛-inch and under, 40 per cent.; do. ⅛ inch and over, 50 per cent.; Double Extra Heavy ⅛-inch and under, 40 per cent. do. do. ⅛-inch and over, 50 per cent.

BUILDING ITEMS.

Mr. G. Schellenger, 128 Broadway, is the architect for the alterations to be made to the buildings Nos. 324 to 328 Fifth avenue, which will be raised two stories, have a six-story brick extension and other improvements made, at a cost of $75,000, for the lessee, Mr. L. Reich.

Mr. Dore Lyon, 249 West 129th street, will build from his own designs, on the south side of 137th street, 185 feet west of Eighth avenue, eleven three-story and basement brick residences, at a cost of $110,000.

On the northeast corner of Ninth avenue, and Ninety-ninth street, Messrs. T. R. A. & W. H. Hall will build ten five-story brick flats, at a cost of $226,000, from plans of Mr. J. C. Burns.

Messrs. Carrere & Hastings, 3 Bowling Green, have prepared plans for a three-story frame cottage to be built on Croton aqueduct line, at a cost of $5,200, for Mrs. O. A. Bancroft.

Mr. Albert H. Hatch will have a six-story brick warehouse, 50.3x81.6, erected at Nos. 402 and 404 Greenwich street, at a cost of $54,000. Messrs. F. & W. E. Bloodgood, masons

Foundations are being laid for the chapel to be built for the General Theological Seminary on the south side of Twenty-first street, between Ninth and Tenth avenues, which will cost about $100,000. Mr. C. C. Haight, is the architect. Messrs. Robinson & Wallace, contractors.

Mr. Jos. M. Dunn has designed for Mr. Robert Goelet, a two-story brick stable, 55x85, to be built at a cost of $10,000 at Nos. 206 & 208 Mercer street. Michael Reid, contractor.

Mr. W. Burrnet Tuthill has prepared plans for extensive alterations to be made to the building No. 59 Broadway, of which Messrs. Warner Bros. are the owners.

Mr. Henry Field will have alterations made to his residence, No 125 East Twenty-first street, which will cost not less than $30,000. Messrs. R. H. Robertson and A. J. Manning, associate architects.

Mr. Ernest W. Greis, 8 Union Square, has prepared plans for Mr. A. Horn, for a five-story brick and terra-cotta tenement, 25x83.6, to be built at 165 Mott street, at a cost of $16,000.

Mr. H. L. Harris, is preparing plans for a four-story residence 18x54, to be built by Mr. Saml. Colcord, for Mr. Simmons, on the north side of Eighty-first street, 200 feet west of Ninth avenue.

A Court House is to be built at Bridgeport, Conn., from designs of Mr. Warren R. Briggs, of that city. Estimates will be received by the Building Committee, till October, 23rd.

Mr. C. W. Romeyn, 206 Broadway, reports plans on hand for the Ulster Academy, to be built of brick and stone, at a cost of $12,000, at Kingston, N. Y., also a residence to be built at same place for Mr. F. J. R. Clark, stone first story, shingles above, to cost $10,000.

Mr. Wilbur S. Knowles, 189 Broadway, has on the boards plans for four houses to be built at a cost of about $16,000 at Glen Ridge, N. J., for Mr. A. G. Darwin, also two houses for Mr. L. J Belloni, Jr., at same place, to cost about $12,000, and one for George Earle to cost $6,500.

Mr. Jos. M. Dunn has drawn plans for a morgue, to be built at North Brothers Island.

Mr. Chas. H. Bliss will build on the north side of Sixty-fourth street, 305 feet west of Ninth avenue, six four-story brown stone residences, at a cost of $75,000, and four adjoining to cost $56,000.

Mr. Edward Marcheder will build on the northeast corner of First avenue and Forty-third street, four six-story dwellings, at a cost of $60,000.

On the southeast corner of Broadway and 111th street, two four-story brick dwellings are to be erected at a cost of $40,000, for Mrs. Ruth A. Stevenson.

The Tenement House Building Co. will build on the north side of Cherry street, west of Montgomery street, four five-story tenements, to cost 0000.

Smith's Falls on the Boom.

The citizens of our neighboring town, says the Perth *Expositor*, seem at last to have wakened up, and say that they don't intend to stop until Smith's Falls is at least the county town of the new county, to be formed out of parts of Leeds, Grenville, Lanark and Carleton, even if the do not manage to become a city. A large amount of building has taken place during the past summer, and still there are no houses to rent, though the railway men have not yet arrived. They are extending their boundaries in all directions, until the town covers 750 acres in addition to street and water lots. Plate glass is making its appearance on the Main street, and business rents are away up.

The source of all this boom is the selection of Smith's Falls as the division terminus on the new air line. The railway company has secured no less than thirty-five acres of land, they are putting up a forty-stall engine house, 500 feet in length of repair shops, a stone station nearly as large as that at Perth, and a railway dining room. Fifty trains a day now pass Smith's Falls, and as soon as the Air line and the Sault Ste. Marie line are opened, the number will be increased to seventy. That means the residence of two or three hundred train hands, conductors, engine drivers, brakesmen and firemen, besides some local men in the shops, and the proportion of merchants and mechanics whom they will bring with them. Meantime lots are booming and Smith's Falls looks prosperous.

The tracklaying on the Air line will soon be completed from Smith's Falls to Merrickville. The rails are very heavy, seventy-two pounds to the yard. It is intended to run a fast train, making the distance from Smith's Falls in two hours and forty minutes, which will be two hours and a half less than by the present route via Ottawa.